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POWER

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NATIONAL CARBON COMPANY, Inc.
New York San Francisco

LIGHT

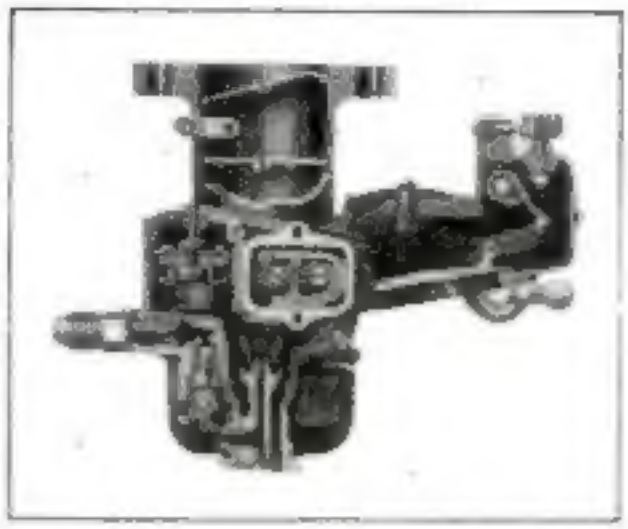
Carburetion

ALMOST everybody knows that proper carburetion can contribute more to superlative motor-car performance—"pep," power, speed, smoothness and economy of operation—than any other phase of motor-car operation.

In simplest terms the carburetor is a device for transforming liquid gasoline into a vapor, mixing it with air, and then injecting the mixture thus formed into the cylinders of the motor. Although the principle is comparatively simple, there are several factors in the process that tend to complicate matters.

For instance, the proportion of air that is mixed with the vaporized gasoline is, for summer driving, different from that used for winter driving. The mixture varies with high engine speeds and low. A richer mixture—that is, one with an increased amount of gasoline vapor—is desirable for speedy "getaway" in traffic.

Perhaps the most important factor in carburetion, aside from having the correct mixture of air and gasoline, is to get the vaporized mixture quickly into the cylinders. Gasoline is caused to vaporize by the addition of heat, and when in the vaporized



Cut-away view of the carburetor designed and built by Cadillac for the Cadillac and La Salle 90-degree V-type engines. It is known as the "air valve single jet type", and embodies a number of exclusive features

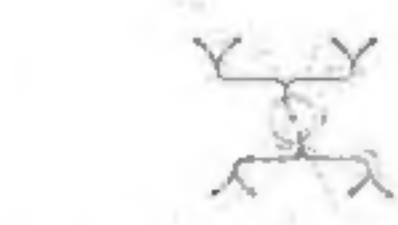
state must be conducted immediately to the cylinders—while it is still hot—or it will change back to a liquid.

There is no other eight-cylinder engine built which permits of such quick distribution of the vaporized gasoline as the Cadillac-La Salle type of engine. A glance at the diagram below will show how short a distance this vapor must travel to be distributed to all eight cylinders of the Cadillac-La Salle engine—and how far it must travel in a motor having its cylinders set one after the other in a straight line.

In the Cadillac-La Salle 90-degree V-type engine the carburetor is placed in the heated space between the two cylinder blocks where conditions are most favorable for rapid and effective vaporization of the gasoline. Since the inlet ports are grouped around the carburetor, the vapor takes a short, direct path to the cylinders, reaching the combustion chambers in its most effective state. An outstanding advantage of this arrangement is that the quality of the mixture is the same in each cylinder—an extremely important factor greatly enhancing the brilliance of engine performance.

One of the marked advantages of Cadillac-La Salle carburetion is that changes of the fuel level in the carburetor, when driving up steep hills, have practically no effect on the carburetion efficiency. Three completely automatic thermostats maintain proper carburetor adjustments for every operating condition. One thermostat regulates the mixture for maximum efficiency in regard to speed. Another thermostat renders seasonal adjustment unnecessary and keeps the carburetor functioning just as efficiently in summer as in winter. A third thermostat governs the action of the special pump that forces extra fuel into the carburetor for quick acceleration.

Cadillac-La Salle carburetion is just one of the many factors that contribute to the brilliant performance of the Cadillac-La Salle power plant—its phenomenal smoothness and quiet, its flexibility, its sensitive response to control, its rapid acceleration, its easy speed.



The line of fuel travel is short to every Cadillac-La Salle cylinder

Fuel must travel far to reach every cylinder when the cylinders are set in a straight line

CADILLAC-LA SALLE

CADILLAC MOTOR CAR COMPANY

Division of General Motors

DETROIT, MICHIGAN OSHAWA, CANADA

WHAT IS NEW THIS MONTH

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September, 1929, Vol. 115, No. 3. **Popular Science Monthly** is published monthly at 381 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Copyright, 1929, by the Popular Science Publishing Co., Inc. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $3.50; foreign countries, $4. The contents of this magazine must not be reprinted without permission. In presenting numerous stories of new products of applied science, **Popular Science Monthly** does not underwrite the business methods of the individuals or concerns producing them. The use of **Popular Science Monthly** articles for stock-selling schemes is never authorized. O. B. Capen, President and Treasurer; R. C. Wilson, Vice-President; A. L. Cole, Vice-President and Secretary.

Do You Know *Your* PRESENT WORTH?

By WALLACE AMES, *Financial Editor*

WALTER HOPKINS sat at his desk. In front of him was a framed picture of his wife and two children. At ages four and five his children understood only the rosy side of life. They knew that new shoes came from the store, but had no idea how the money was obtained to pay for them. Lucy Hopkins was a delightful young woman, but she was trained in ways of home-making and child-culture, not in the ways of business. Walter was the business head of the family. It was an ideal combination.

Every time he looked at the picture Walter experienced a thrill of pride . . . mingled with a feeling of dis-satisfaction bordering on fear. A good job, a nice home and a fine family—why should he not be proud? But what if something should happen to him, the bread-winner, and the ideal combination be broken up? It was only natural that he should experience concern over the future.

Walter reached for his personal finance book, as he had often done before. It was all down in black and white. Their home, which they were buying through a building and loan association, was partly paid for. There were a few hundred dollars in the savings account, a satisfactory balance in the checking account and about $5,000 in securities in the safe deposit box. All told, Walter was worth about $10,000, and then there was his $10,000 life insurance policy. Just an average situation for a married man, 33 years old, earning $7,000 a year.

A few hours before the incidents just mentioned Allan Case was running through his card file. Up came Walter's card, indicating that he was soon to pass from his 33th to his 34th year. "I'll see Walter today," said Allan, "and bring up the question of more insurance before his rate advances." And so it happened that at the psychological time Walter received a visit from his insurance adviser.

"I am glad you called," greeted Walter. "I have just been going over some records that show my financial worth at $10,000. A few years ago that would have looked like a lot of money. But it makes me shudder to think how little it would be now for my family to live on in case I should pass out of the picture. How about another $5,000 insurance policy?"

"Before we get out the application blanks," suggested Allan, "let us do a little figuring and projecting and determine just how much insurance you should carry. The way you figure, you are worth $10,000. That, plus your $10,000 insurance is what you are worth—dead. The way I figure, you are worth about $116,000—alive."

"That's interesting," said Walter. "I have looked at my records many a time, but I never saw any such figures as you mention. How do you arrive at them?"

"Just this way," answered Allan. "At your age you may normally expect to live about 32 years. Let us assume that you continue to earn $7,000 yearly on the average for the rest of your life. If you had $116,000 now, invested at 4½%, you could draw out $7,000 a year for the next 32 years and not until the end of that time would you have used up both principal and interest. Thus the present worth of your future earning power may be figured at $116,000."

"You are not leading up to the suggestion that I insure now for $116,000, are you?"

"Hardly," assured Allan, "but you need more than $5,000 additional insurance to provide properly for your family. You probably consume half the family income yourself. In the average instance the widow and children live comfortably on half the income earned by the husband while he was alive. To replace the present worth of your earning power you do need at least $50,000 worth of life insurance.

"Suppose you carried $50,000. The annual premiums would be a little less than $900 or about $75 monthly." "I could dig up $75 a month easily enough," said Walter, "but $50,000! I would hate to think of all the sharps and swindlers who would be following up Lucy if she suddenly fell heir to that much money. She is a wonderful wife, but she has had no business experience. She would be the prey of all the phoney stock salesmen in existence."

"There are several ways for you to protect your wife against bad business judgment," said Allan. "One way is to make your insurance payable as monthly income. You could get a $30,000 policy which would pay back $250 a month for about 400 months before both principal and interest was gone. That's nearly 34 years. Such a policy would provide your family with that part of your future earnings which they will enjoy if you continue to live and earn your present income.

"There is another plan that has gained great popularity of late years—the life insurance trust plan. You create your estate by taking out life insurance and you arrange to have your life insurance estate administered in much the same way you would an estate consisting of cash and securities. This is a fairly modern idea, but already there is substantially over a billion dollars of life insurance in force under the plan.

"The advantages of the life insurance trust are many. You immediately provide your family with (Continued on page 5)

Do You Know Your Present Worth?

(Continued from page 4)

a comfortable living income. You relieve your wife of all the business worries of handling a large sum of money. She gets her pay checks much the same as you get yours now. She knows what to depend on, absolutely. You obtain the benefits of skill and experience in the investment of your estate. You are sure that your money is held in carefully selected securities. You know that those securities are watched continually and that changes are made as circumstances justify. Your family is more surely provided for than you are providing for them now.

"Broadly speaking there are two forms of life insurance trust, one set up with a trust company, and the other arranged with the insurance company. The chief difference between the two arrangements is the matter of flexibility. In the insurance company plan your beneficiaries are paid a regular income, which is close to 5% of the principal amount. The insurance company is not permitted to meet emergencies or special conditions not covered in the original agreement. For example, it could not pay an extra $1,000 out of principal to defray hospital expenses. It could not make a special payment for educational expenses unless a special policy was provided for that purpose. Your beneficiary gets a definite sum at regular periods.

"If you set up a life insurance trust with a bank you can make various stipulations, just as you would in drawing a will. You can specify that the estate be invested in certain types of securities, or you can leave that to the bank's discretion. You can arrange so that special sums can be paid under certain circumstances, such as in case of sickness, or when your children are ready to go to college. You can if you like set a maximum that will be paid out on these special occasions.

"Under the bank-trustee plan your estate may grow in principal value, or it may decline. Under the insurance company plan your beneficiary continues to draw her income from a stipulated, non-fluctuating principal sum.

"You have said enough," interrupted Walter. "Let us figure out what provisions in the agreement would be practical at this time and have the papers drawn up. It will be a great source of satisfaction to know that my family is provided with an estate of $50,000 which cannot be squandered or frittered away."

For the past three years POPULAR SCIENCE MONTHLY has carried this Getting Ahead Department as a regular monthly feature. It has been the aim of the editor to discuss financial subjects of interest and application to the average man or woman. We have written about life insurance, building and loan associations, mortgage bonds, investment trusts, public utilities and other classes of securities, about budget plans for accumulating a modest fortune quickly and safely and about various phases of personal and family finance. (Continued on page 6)

Do You Know Your Present Worth?

(Continued from page 5)

The financial editor would welcome letters from readers indicating subjects in which they have particular interest. Letters relating personal experiences in getting ahead, or giving the details of plans or methods which have succeeded, or failed, are also welcome. We extend this invitation to write us as a means of making this department of greatest usefulness to our readers.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. **"55 Years of Investment Service"** describes the history of progress of the F. H. Smith Company as well as making an attractive suggestion in first mortgage real estate bonds. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

"The Investment Trust from the Investor's Viewpoint," presents an explanation of this form of investment in easily understood terms, illustrated with some interesting examples of how the general investment trust will help the man with $100 or more to get ahead. Published for free distribution by United States Fiscal Corporation, 50 Broadway, New York. Ask them for Booklet fT.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

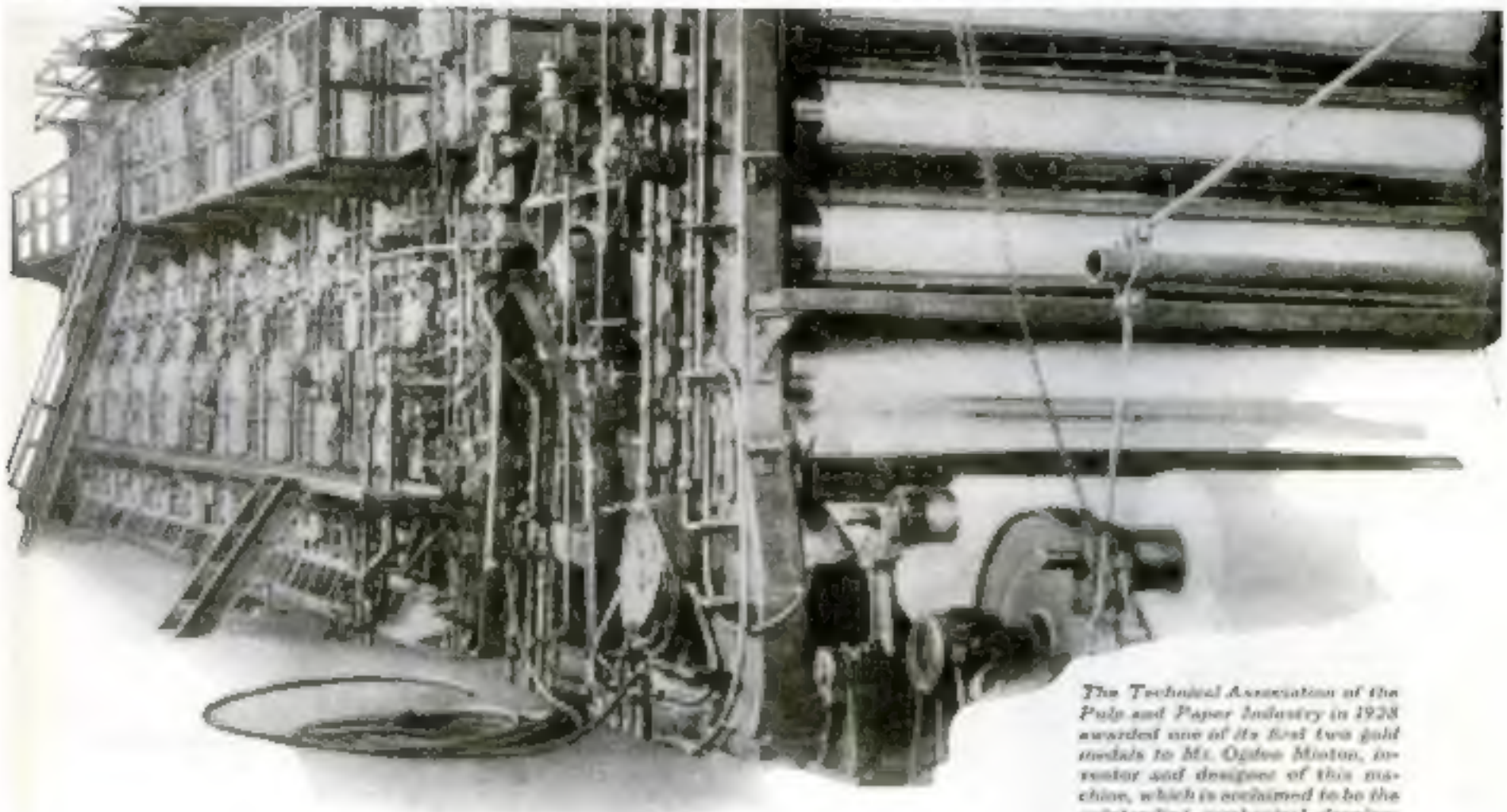
How to Get the Things You Want tells how you can use insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 318 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

The Investment Trust from the Investor's Viewpoint is a booklet describing the investment trust in non-technical language, published by Smith, Reed & Jones, Inc., 1405 Chase National Bank Building, New York. This booklet explains how both earning power and safety are applied to moderate sums of money through the instrumentality of the investment trust.

$25,000 WORTH OF SKF BEARINGS ARE IN THIS MINTON VACUUM DRYER



The Technical Association of the Pulp and Paper Industry in 1928 awarded one of its first two gold medals to Mr. Ogden Minton, inventor and designer of this machine, which is acclaimed to be the outstanding mechanical development in the Paper Industry for the last sixty years.

Bearings, Bearings and More Bearings— But ALL are SKF

THE fibres of the great northern spruce flow day after day in a thick milk-white stream of pulp over screens, onto finely meshed wires and through heavy presses that extract tons of water from the soggy mass.

A web of paper at the rate of 120 tons per day, almost 20 feet wide, miraculously begins to flow before your eyes and then passes about 1,000 feet per minute into the Minton Vacuum Dryer, where it is dried under a high vacuum.

And at practically every point where a wheel or roller turns, there's an SKF Ball or Roller Bearing reducing friction, eliminating power waste and minimizing the possibility of expensive shut-downs. Few industries know the worth of a quality bearing better than that which produces the world's paper. In the great vacuum dryer shown on this page there are one hundred and fifty-two heavy duty SKF Bearings that cost $25,000! And yet its designer, with a full appreciation of the fact that "nothing is apt to cost so much as a bearing that cost so little," KNOWS that even THAT price is not too much to pay for DEPENDABILITY.

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POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use.

Tools, Radio Apparatus, Oil Burners and Refrigerators advertised in POPULAR SCIENCE MONTHLY have been tested or investigated by the Popular Science Institute of Standards and each advertisement carries the insignia indicating approval.

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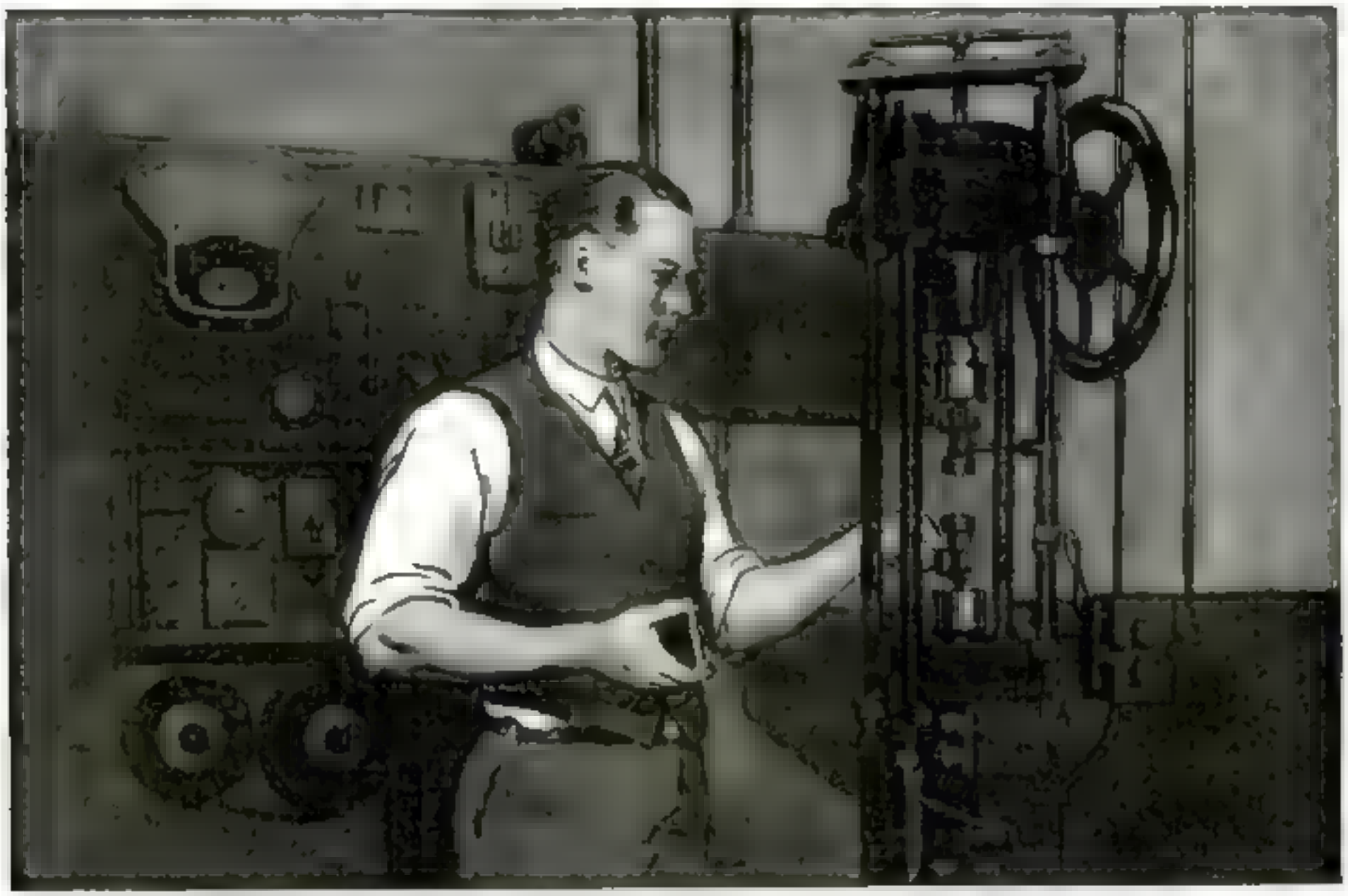

WESTINGHOUSE ENGINEERS HAVE DEVELOPED SPECIAL MACHINES IN WHICH THEY MEASURE THE DYNAMIC STRENGTH OF MATERIALS UNDER ACTUAL SERVICE CONDITIONS

DAY-FAN RADIO

Champions Quality in Construction

YOU will discover the excellence of Day-Fan Radio quickly enough. It is plainly evident in a finer, purer tone quality, greater degree of sensitiveness, sharper selectivity, extra power, reserve volume, smoother operation. These qualities have been achieved by *sound* engineering design.

We improved upon a basic design which had already produced splendid results—the tuned-radio-frequency circuit employing 9 tubes. The audio amplifier, fundamentally correct, came in for refinement. Two 245 tubes are now used in push-pull in the final stage. Impedances of each part are very accurately matched, one to another. A specially designed dynamic speaker is balanced with the power output.

The studied placement of tubes to avoid inter-action and lining up of coils and condensers with respect to tubes have increased the set's efficiency, reducing wiring by 50 per cent. Throughout, in the manufacture of this new model, the greatest emphasis has been put upon the necessity for the best material and for ample material in every part—and for painstaking adjustment of the whole set.

MORE Value Built into a DAY-FAN Chassis than Ever Before

THE cost of materials and workmanship necessary in the production of the chassis in the new Day-Fan is greater than that of any other set we have ever built. This is certainly conclusive evidence of quality in construction. Our engineering staff did not work within a price limit. Their job was to create the best. But we have reduced the prices on Day-Fan sets because of a greater volume of sales expected and already made.

A few construction features of the new model:

The variable tuning condenser—mounted on ball-bearings—is large, and high-geared; it makes exact tuning easier, throughout the broadcasting range.

Dial lighted from inside, is graduated in kilocycles as well as index numbers.

Phonograph pick-up connection and switch. Pick-up can be left connected permanently; switch selects either the radio or phonograph for playing through the audio-amplifier of Day-Fan.

Day-Fan Radio is now offered in three beautiful walnut consoles and one walnut table model. The large console, Model 69, is shown above. It contains the 9-tube chassis and the special Dynamic speaker. Price is $225.* Another console, massive in line, is $175.* and a pleasing small console is $169.50.* Table Model is $115.* For use with Table Model we recommend special Day-Fan Dynamic Speaker to match, priced at $35.*

* * *

**Prices of sets, less tubes; prices slightly higher west of Rockies.*

Day-Fan Electric Co.
1709 W. Jefferson Blvd.,
Dayton, O.

Please mail me descriptive literature on Day-Fan Radio. Tell me where I can hear a demonstration.

Make Your Building Dollars Pay

Why a Home of Sound Construction Gives More for the Money Than a Flimsy One with Fancy Fittings

By COLLINS P. BLISS
Director, Popular Science Institute

A discerning eye for points of good construction will prove extremely helpful in sticking on the fundamentals.

IN OUR neighborhood are two new houses which, I understand, cost about the same to build. Two more different ways of investing the same number of building dollars would be hard to imagine but both owners, Mr. Adams and Mr. Doan, are thoroughly satisfied for the present, at least. It will be interesting to learn how they feel about it five years from now.

Architecturally, there's nothing wrong with either house. Both are attractive. Possibly this is because the same architect designed both. But when it came to deciding what materials were to go into the houses, the individual owners did their own choosing, and one of them, I think, failed to use good judgment.

Choose the Essentials

Almost every home builder plans to spend a stipulated sum of money. For that money he can get just so much house. Necessarily there will be some things to the way of materials and conveniences he will have to forego. Many people like my neighbor Mr. Adams choose certain features that at the time seem very desirable and omit others which are much more essential to lasting satisfaction. It always is hard to draw the line, but certainly the home builder who invests each dollar with discretion will not have to sigh at a later date and wish he "had it to do over again."

Where I think my neighbor Adams made his big mistake was in foregoing essentials of good construction for superficial beauty that he might have added at a later date when he was in a better position financially to indulge in luxuries. For instance, he skimped on the bracing of floors to an extent that soon he is likely to find the wall plaster cracked in most of his rooms. With the money thus foolishly saved he bought a beautiful staircase—a much costlier one than the other neighbor, Mr. Doan, was able to put in his house. He also installed an extraordinary rosewood fireplace, all hand carved. This long had been his ambition, and I suppose it is worth something to satisfy it. But he might have done better instead to roof his house with lasting material, such as Doan chose. Then instead of reroofing in five years, he could replace a first simple fireplace with a fine one. There would be less waste in discarding an inexpensive fireplace than a roof.

The third floor of the Adams home boasts a well equipped billiard room, while the same space in the other house is finished off rather simply for a playroom. Adams is going to find his billiard room hot in summer and hard to heat in winter because he vetoed the architect's suggestion to line the roof with a layer of good insulating material. His neighbor on the other hand thought well of the idea of insulating and figured that aside from the comfort derived, he would save enough on fuel to fix up his third floor room more elaborately in a few years.

These are only a few examples of how differently these two men chose to spend their money. Throughout Adams considered surface beauty and neglected livability. Doan watched out both for comfort and for upkeep cost, and my guess is that he will be increasingly satisfied with the sort of home he has chosen.

I suppose if the two houses were put on the market for sale today, the Adams house would go quicker. Its surface attractions would sell it. On the other hand, it would take some salesmanship to put over the value of the fine heating system, substantial plumbing, and general sturdy construction of the Doan house. It is one thing, however, to build a house for speculation and another to build a house with the intention of living in it over a period of years. A fancy fireplace is not going to be much help if the heating system falls down on its job, and elaborate lighting fixtures will not give enough pleasure to offset the pain of seeing the house settle because of poor construction.

These are things that every man who is building a house for his family must consider when formulating his plans. There must always be a stopping place in expense but stop at the nonessentials that can be added later and do not make the mistake of economizing on fundamentals. A well constructed house lasts a long while—much longer than prevailing style or momentary fad.

INSTITUTE BULLETINS

- Insulation in Building Construction*
- List of Approved Radio Products
- List of Approved Tools
- List of Approved Oil Heating Devices
- Advice on Installing Oil Heat
- List of Approved Refrigerators
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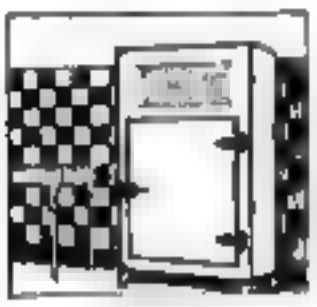
*Price 25 cents each

A cold place to keep eggs, a warm place to hatch them . . made with this grainless wood

There are hundreds of industrial applications for the grainless wood board, Masonite Presdwood. The Presdwood booklet lists eighty of its uses and may suggest ways in which you, too, can use Presdwood to improve a product or lower manufacturing costs. A sample of Presdwood and a copy of the booklet will be sent, free, on request.



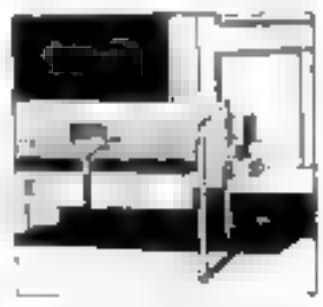
FOR CEROX CABINETS

A de luxe ice box, that is made in Detroit; an incubator, which comes from Racine; an outdoor sign from Kalamazoo, advertising baby chicks. These things and scores of others, ranging from tiny toys to monster motor truck bodies, are now made of this grainless wood, Masonite Presdwood.

For panels, painted or unpainted

The entire outer cabinet of the ice box is made of this grainless material because of its hard, smooth surface on which commercial finishes can be so readily applied. The incubators are made of Presdwood because it is weather resisting, strong, easily punched or cut with any woodworking tools and so naturally attractive that a paint finish is not required.

Carload after carload of Masonite Presdwood goes to makers of signs of all kinds. The sign builder at Kalamazoo is just one of many. He cuts out giant "chicks" as advertisements and sells them to breeders of fancy poultry who wish to advertise their business along near-by roads.



FOR STURDY INCUBATORS

Presdwood is used for scores of other things. It makes smooth beds and rails for portable billiard tables. It makes cooling trays for castings, starch trays for candy factories, bedroom screens, doll houses, toy animals for children to play with. It panels walls and ceilings of fine homes and the offices and corridors of the better type office buildings. Used to line concrete forms it gives such a perfect, smooth surface that the need for hand rubbing and grinding is eliminated.

Send for this booklet

Eighty uses for Presdwood, many of them attractively illustrated, are listed in the Presdwood booklet. It will certainly pay any industrial executive, builder or home owner to get a copy and learn more about the advantages of wood that is grainless. The booklet and a sample of Presdwood will be sent, free, on request.

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FOR SIGNS AND CUTOUTS

Masonite PRESDWOOD

Made by the makers of
MASONITE STRUCTURAL INSULATION

FOR MOTOR TRUCK PANELING

Our Readers Say—

Standing on the Seat

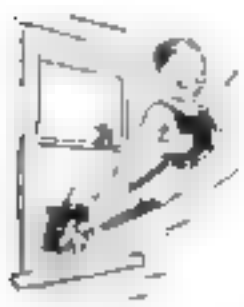
"NO ARTICLES you have printed for several years have appealed to us like those by Larry Brent. Personally I'd gladly miss a meal for a copy of your magazine. I am just an ordinary happily married woman, whose first thoughts are for my husband, two children, and home, but I am intensely interested in progress, and in aviation in particular. I wanted my boy to be a surgeon, but at present his whole soul is surrounded, and I think when he is twenty-one I'd rather he'd be a man poet in love with life and happy in his work than to have a string of letters after his name and a subconscious regret that he was a round peg in a square hole.

"I do not doubt that Lindbergh in his barnstorming days was censured by some old fogies as being too lazy to work etc., but what cared he or what cared the world when he pioneered the trail where the industrious and careful were too faint-hearted to dare?

"Larry Brent's articles have answered nearly all the questions I was dying to know about learning to fly, and if I were single I wouldn't get to an instructor quick enough to try to learn to fly. From the first plane I ever saw until today I have thrilled to the glory of airplanes and have longed to sit at the controls. Years ago I sat on the hurricane deck of a little gray Spanish pony, headed into the wind, and shrieked myself hoarse, drunk with the joy of motion. That was life! Now I drive a motor, sedately and carefully for my children's sake, while my soul stands on the seat, waves its hat, and yelps with joy. Again I thank you for Larry Brent."—Mrs. I. L. P., Elena, Tex.

The Breezy Life

"AFTER reading your articles on house insulation, and seeing what your Popular Science Institute is doing to aid home builders in this direction, I certainly was surprised to read an article in your last issue in which Dr. Leonard Hill of England advocates 'drafty and cold dwellings' to promote health.



"Doctor Hill argues that if a house is made drafty and uncomfortable, the family will be forced to get outdoors and exercise more, and therefore will be healthier. A grand idea. After that vigorous and healthful exercise outdoors, I suppose it is fine for the family to come into the cold house and sit around to drafts to cool off.

"Plenty of fresh air is all right in its place, but what are modern homes for if not to provide shelter—and comfort? What do you think?"—D. B. J., Boonton, N. J.

This Is Good Tonic

"I HAVE been using POPULAR SCIENCE MONTHLY for supplementary science work for a number of years, and it is the best I have ever found to stimulate outside research and investigation of current scientific experimentation. My pupils can scarcely wait for the new numbers. I consider it of inestimable value in my classes and we think every issue becomes more interesting and valuable."—Mrs. F. B. D., North Junior High School, Joplin, Mo.

And So Is This

"I USED to wonder at the number of people with whom I came in contact who seemed to be able to keep up with the advances in matters scientific. Then I got intimately acquainted with POPULAR SCIENCE MONTHLY. I had to wonder no longer. I have [illegible] contented success."—H. G., Brooklyn, N. Y.

Vacationing at the Pole

"WHAT gets me and many more like me is this for northern country is why Byrd should have had such a hard time selecting the right kind of men to suffer the hardships of a trip to the South Pole.

"We up here consider a trip to the South Pole with Byrd a vacation with every possible convenience that money would buy—radio, moving pictures, etc.—and get all the latest news every day if they want it, and also send news back to the outside world.

"They talk of hard ships, with the best of everything to draw from. The only chance they will take is when they go by plane and have to make a forced landing. And then it's no bigger chance than the pilots here in Alaska are taking every day flying all over the Territory in pretty rough country, [illegible] and fifty degrees below zero weather and very few places to land.

"If Byrd wanted men for his South Polar trip he would have had no trouble in getting his men from Alaska or the Yukon. I am willing to bet that if Byrd reports the discovery of gold at the South Pole, you will see every old sourdough in Alaska hitch a pack on his back or pull a sled by the neck and hit the trail for the new strike. And they would get there, too."—G. S. Chicken, Alaska.

How Many Can You Answer?

"THE letters picking flaws in your rovers were quite interesting, but struck a little too close home to be funny. Being a commercial artist, I've had plenty of grief that way myself, although I consider myself fairly well informed and think I am a rather accurate observer.

"No one but an artist can realize the difficulty of being all things to all men. The artist whom these gentlemen are panning in their letters is a very careful workman, and the fact that he has slipped up only emphasizes the difficulty. I have frequently remarked that Herbert Paus is the only artist whose stuff was invariably correct. Out of several thousand men who drew war pictures, I believe he is the only one who could draw a steel helmet.

"I'd like to put down a few questions such as an artist might have to answer in the course of his work. Let the snipers look them over and try to answer them.

"What is the exact shape of an ax handle?

"Does a lumberjack wear his pants inside or outside his boots?

"How is the radio aerial rigged on an ocean liner?

"What kind of hat does a high-class Korean wear?

"Does a Japanese lady tie her sash in front or in back, and how?

"What are buck rig rails?

"How does the riding position of an American jockey differ from that of an English jockey?

"Has an elephant a tuft of hair on the end of his tail?

"Has the Packard an ornament on the radiator cap?

"How does a steel worker carry his wrench? And, incidentally, what kind of a wrench?

"What is the approximate height of a French loaf in proportion to the length of the foot?

"What kind of a steering mechanism has a caterpillar tractor?

"What is the exact shape of the shafts on a hansom cab?

"I guess that's enough to give you an idea as to just how dumb an artist must be in order to [illegible] everything. I have not mentioned a thing that I have not had to answer myself within the last few weeks.

"The artist's primary interest must be the artistic quality of his production, and in the struggle to achieve that, he stands almost alone."—D. F., Chicago, Ill.

An Inventor's Troubles

"AN EDITORIAL in POPULAR SCIENCE says 'How to get rich.' I think it should read 'How the rich get richer and the poor get poorer,' for as far as I can see the more a poor man tries to get rich through invention the poorer he becomes, for someone else has all his money before he can get his invention on the market. I do believe that more useful ideas have died in the memory of unfortunate men than there ever were patented.

Where is the rich man who will help the poor man with an idea and be it honestly as to a brother or a friend in need?"—J. S. P., Glenfield, Pa.

The Cyclops Mystery

"I HAVE read with much interest Alfred P. Reck's article on the disappearance of the *Cyclops* during the war. I want to add my bit to confirm his solution.

"After the war an old friend of mine who served in the Navy discussing the *Cyclops* said to me 'There is no mystery to it. I was on the collier *Orion*, a sister ship to the *Cyclops*. These vessels are so top-heavy that they roll terribly. In a wind the *Orion* would roll over until I thought she would never right herself. The *Cyclops* was probably overloaded, was struck by a severe blow, turned over and sank like a rock."—D. E. L., Three Lakes, Wis.

SHOOTS a 76 . . . *but can't get in a club*

IT sounds incredible until you know the facts as they know them in San Francisco.

Aside from his deadly ability at golf, he possessed a natural charm that made him most engaging to both men and women. Yet no one was willing to propose him for club membership, for he had one fault that simply could not be excused. He, himself, didn't realize what it was—and no one had the courage to tell him.

Only those blind to facts assume they never have halitosis (unpleasant breath). Actually 1 out of 3 offends, occasionally or habitually, surveys show. This is due to the fact that everyday conditions such as pyorrhea, defective teeth, fermenting food particles between teeth, and minor infections of the nose and throat cause it.

Why offend others, when you can keep your breath beyond suspicion by using full strength Listerine three times a day, as a mouth wash?

Being an active germicide,* it attacks the cause of odors and then, being a powerful deodorant, destroys the odors themselves. Keep a bottle handy wherever you are. Lambert Pharmacal Company, St. Louis, Mo., U. S. A.

* * *

***Though safe and healing in action, full strength Listerine kills the virulent Staphylococcus Aureus (pus) germs in 15 seconds; also the Bacillus Typhosus germs—200,000,000 of them—within the same period.**

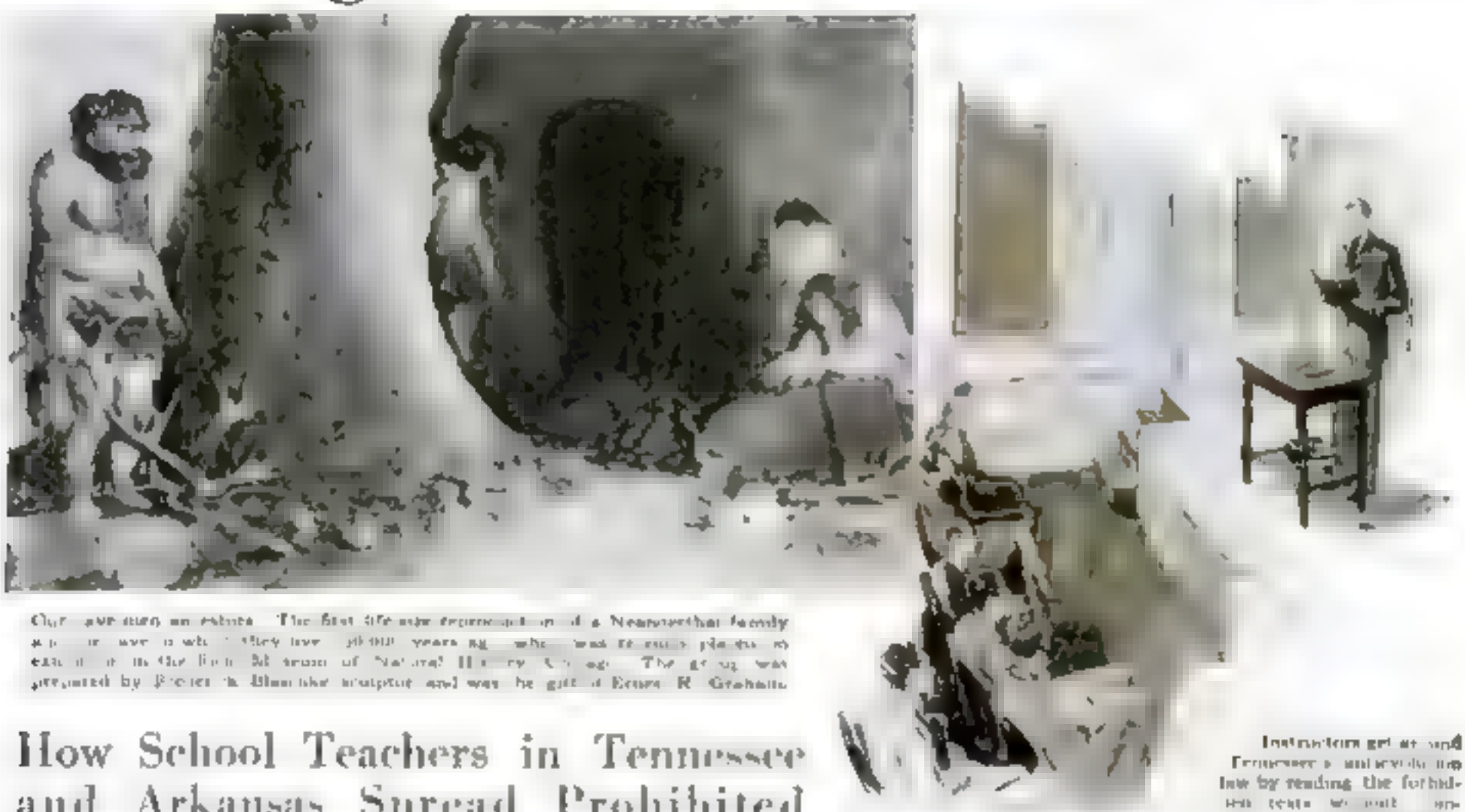
LISTERINE

THE SAFE ANTISEPTIC

Popular Science MONTHLY

SEPTEMBER, 1929 SUMNER BLOSSOM *Editor* VOL. 115, NO. 3

Beating the Evolution Laws



Our ape-men on exhibit. The first life-size reproduction of a Neanderthal family group ever to be shown was built many years ago, when it was the plan to exhibit it in the Hall of Man of Natural History College. The group was designed by Professor Blanchard sculptor and was the gift of Evans R. Graham.

Instructors get around Tennessee's anti-evolution law by reading the forbidden texts without comment. This, they hold, is not teaching evolution.

How School Teachers in Tennessee and Arkansas Spread Prohibited Knowledge by Ingenious Evasions

By ORLAND KAY ARMSTRONG

WITHIN a few weeks, the state of Arkansas is to become the scene of an entirely novel form of law evasion. The illicit traffic will not concern itself with whisky, gin, or other ardent spirits, but with as intangible and non-intoxicating a commodity as a scientific doctrine.

Last November, the people of the state, by popular referendum, created a new kind of prohibition. They placed upon their statute books a law forbidding the teaching of the theory of evolution in educational institutions supported by public funds. Under the provisions of the act, a teacher found guilty of the "misdemeanor" will be punished with a fine of $500 and the loss of his job.

Imported by mail. Nothing in the Arkansas law prevents a student from ordering books on evolution from another state.

Does this mean that, from now on, all pupils of elementary and high schools and all college and university students in Arkansas will be graduated in complete ignorance of the evolution theory and of what it implies in connection with the origin of man? By no means. On a recent tour of the "antievolution belt" I discovered that the reopening of the schools this fall will find many of the teachers fully prepared to pour the prohibited information into the minds of the young Arkansans in their charge in a variety of ingenious ways.

Four years ago an obscure country schoolmaster, John T. Scopes, suddenly became the center of international attention by being tried, under the laws of Tennessee, on a charge of teaching evolution in the high school where he was a biology instructor. After a sensational trial, Scopes was convicted.

Since then, laws similar to the Tennessee act have come up for passage in a number of states. Determined groups have fought for them in the legislatures. A mild antievolution bill was placed on the statute books of Mississippi in 1926. Last spring the legislature of Texas was the scene of a long and spirited battle over such a law, and it came close to being passed. But nowhere have the opponents of the evolution theory won such a sweeping victory as did those in Arkansas. Not only was the measure adopted by popular vote, but it is much more stringent than that of Tennessee, which provides a fine of only $100 for violation. Moreover, the Arkansas bill prohibits the use of textbooks dealing with the subject, while the Tennessee act is silent on that point.

WHAT is this theory of evolution which thousands of Americans believe to be the propaganda of anti-Christ and which, they erroneously insist, teaches that man is descended from apes? Briefly, it is a scientific hypothesis to the effect that the world and all life upon it have been developed since

the beginning of time by slow, orderly processes of change which are still continuing. Scientists consider this theory the only adequate explanation of the mysteries of the origin and development of life. It coördinates the accumulated knowledge of mankind in such a way as to show that every animal, plant, and piece of matter has sprung from a few simple forms, changing through the ages usually from the simple to the complex and toward greater perfection.

AS A matter of fact, it holds that all life, including man himself, probably developed from a single form—a mere cell. Being a philosophy of change, it is the direct opposite of the philosophy of fixed unchangeability, and thus contradicts the idea that everything on earth was created and completed in an instant. It interprets the Biblical story of creation found in Genesis liberally rather than literally. As for the origin of man, neither Darwin, the father of the theory of evolution, nor any other scientist, has ever contended that man is descended from the monkeys. Science has suggested, and research has tended to substantiate, their common ancestry, probably in a small tree-dwelling animal resembling the lemur.

And how does the Commonwealth of Arkansas forbid the teaching of this theory? Here is the text of the principal parts of the new law:

"BE IT ENACTED BY THE PEOPLE OF THE STATE OF ARKANSAS

"Section 1. That it shall be unlawful for any teacher or other instructor in any University, College, Normal, Public School, or other institution of the State, which is supported in whole or in part from public funds derived by State or local taxation to teach the Theory or Doctrine that mankind ascended or descended from a lower order of animals and also it shall be unlawful for any teacher, textbook commission, or other authority exercising the power to select textbooks for above mentioned institution to adopt or use in any such institution a textbook that teaches the doctrine or theory that mankind descended or ascended from a lower order of animals.

"SECTION 2. Be it further enacted that any teacher or other instructor or textbook commission who is found guilty of violation of this Act by teaching the theory or doctrine mentioned in Section 1 hereof, or by using, or adopting any such textbooks in any such educational institution shall be guilty of a misdemeanor and upon conviction shall be fined not exceeding five hundred dollars ($500.00), and upon conviction shall vacate the position thus held in any educational institution of the character above mentioned or any commission of which he may be a member."

Among the men and women high school teachers and normal school, college, and university instructors I interviewed, many of them active members of churches of various denominations, I did not find one who had a good word to say for the law. Their attitude is best expressed in the words of one Arkansas high school teacher who said:

"The main reason for the passage of such measures is that the legislators or, in the case of this state, the agitators who are responsible for the stand taken directly by the people, apparently have not taken the trouble to acquaint themselves with the theory of evolution or to read Darwin's *On the Origin of Species*. Their conception of the theory doesn't seem to go much beyond the old vaudeville jokes about man's ancestors being monkeys."

The teachers of biology especially feel that the law, if strictly adhered to, would take the ground from under their feet. And so a majority of the instructors are determined to "beat" it if they can do so without getting themselves into trouble.

Another loophole. Teachers refer students to library reference works on evolution and still keep within the law

How will they get around it? By using modified forms of teaching and textbooks that have been revised, some of them in an amusingly subtle manner.

"In lecturing to my students in biology and zoology," a teacher in one of the higher institutions of Arkansas told me, "I inform them that on November 6, 1928, the people of this state decided that there were three divisions of organic life—man, animals, and plants. The law does not care what we teach about animals and plants, nor how we teach it. As to man, I tell my students plainly that it is illegal to apply to the human race the same method of study and the same drawing of conclusions that we apply to the lower orders of life. Rather than dampening their ardor for acquiring knowledge, this seems to create a spirit of investigation that gets results."

Another instructor—a teacher of science—outlined his particular plan of evasion in this wise:

"At the opening of the course this fall, I will pile up my textbooks and reference works on the table before me and I will say to my students:

"'The matter contained on pages so-and-so of such-and-such a book is illegal under the antievolution law. I do not want to break the law, so we shall omit those pages from the discussions. But I shall hold you responsible for all the reasonable facts discoverable in this course.'"

AND that brings up the matter of text and reference books. The law specifically forbids the adoption or use by institutions wholly or partly supported from public funds of *textbooks* that teach the theory of evolution, but it makes no mention of *reference books*. Here is another loophole, for the teachers, especially instructors in normal schools and universities, which maintain adequate libraries, may refer their students to reference works on the subject and remain within the limits of the law.

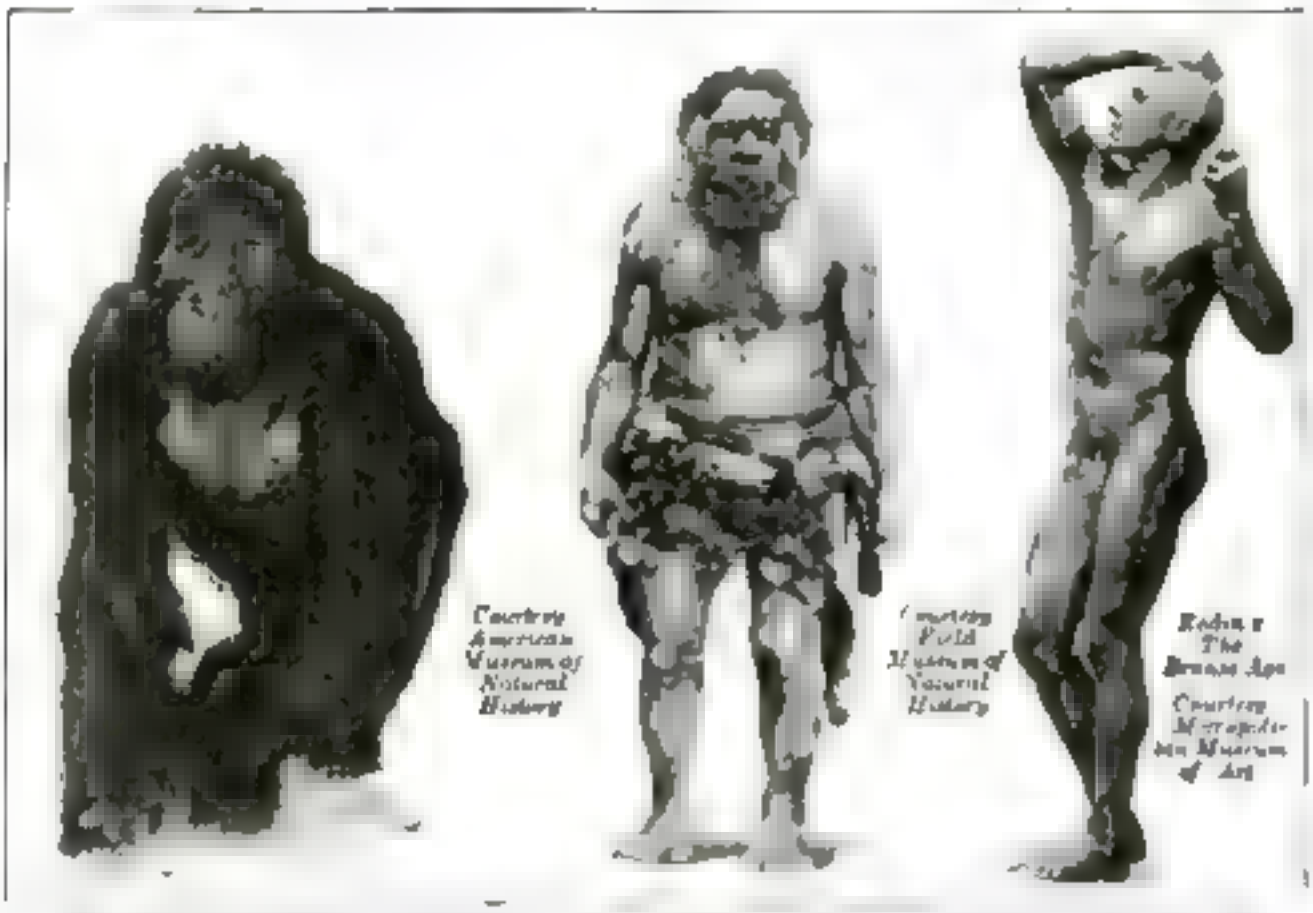
"I may not teach the theory of evolution,' a university professor told me in this connection, "but I see no provision in the law which prevents me from saying to my students:

"'As you know, the teaching of the theory of evolution is prohibited. But if you wish to find out what it is all about, you may do so by consulting such and such reference books in our library.' Surely such a suggestion could not be interpreted as teaching, using, or adopting a textbook—our three new misdemeanors."

Moreover, what of the public libraries? In most cases, they doubtless come under the head of institutions supported in whole or in part from public funds. The law, however, makes no specific mention of them. While it is true that Section 1 of the act refers to "any University, College, Normal, Public School, or *other institution* of the State," yet Section 2 plainly states that the use or adoption of textbooks teaching the evolutionary theory shall henceforth be taboo in *educational* institutions. Is a public library an educational institution in a strictly legal sense? If it is not, it may keep the forbidden textbooks on its shelves. If it is, it will have to content itself with books of reference only.

THEN, too, as another teacher pointed out to me, the act differs from the National Prohibition Amendment in that it does not forbid the manufacture, sale, import, or export of books explaining or teaching the theory of evolution. In other words, they may be printed, sold, and bought in Arkansas or shipped into the state, and there is nothing to keep an eager student from buying them at a bookstore in any Arkansas town or ordering them directly from a publishing house in another state.

On the subject of the use of textbooks in the public schools, however, the language of the law leaves no doubt as to the will of the people. The Textbook Commission found a great variety of scientific textbooks in use in the state, for there is no uniform school-book list in Arkansas, as there is in Tennessee. A great scramble to find books that were



Three stages of evolution—the gorilla, nearest approach to man among animals, mounted by Carl Akeley; Neanderthal cave man, reproduced by Blaschke, and modern man depicted by Rodin.

Exhibits in Arkansas museums of anthropology may get by the law by telling their own story of evolution silently.

adaptable to the law ensued. Many schools changed books in the middle of the year. At the opening of the new school year this autumn, most of the teachers will be ready to evade the law with revised or new textbooks in which evolution is given little or no direct attention. The majority of the revised books substitute the word "development" for "evolution."

It was Hunter's *Civic Biology* that caused the trouble in Tennessee. This book and Moon's *Biology for Beginners* were used in the biology courses in the largest high school in Arkansas, that at Little Rock before the law was passed. For them have been substituted *Practical Biology* by Smallwood, Reveley, and Bailey, and *Biology and Human Welfare* by Peabody and Hunt.

In Hunter's book, under the heading, "Evolution of Man," there occurs this passage:

"UNDOUBTEDLY there once lived upon the earth races of men who were lower in their mental organization than the present inhabitants. If we follow the early history of man upon earth, we find that he must have been little better than one of the lower animals."

It was Scopes's comment upon those words that caused the historic Dayton trial.

Small wonder that the book is taboo in Arkansas! In *Practical Biology*, the approved text, all reference to man is carefully avoided and the subject is treated in this manner:

"Evolution, in a larger sense, is the theory or belief that all of the complex animals and plants on earth today developed from the simpler animals and plants of many generations ago. This theory tries to prove itself through the careful study and investigation of the relations between animals and plants of the present and those that formerly existed.

But not all the high schools of Arkansas have discarded the older texts. The faculty of a school in one of the larger towns decided to retain Hunter's book, and simply instructed the students to tear out the pages dealing with evolution. The book was used in that way the latter part of last term, and will be used in the same manner this coming year.

Moon's book was considered the most objectionable of all the high school texts and became the target of antievolution agitation in Arkansas, as it had before in Tennessee and other states.

The author's straightforward treatment of the forbidden subject is clearly seen in his discussion of "Relationship":

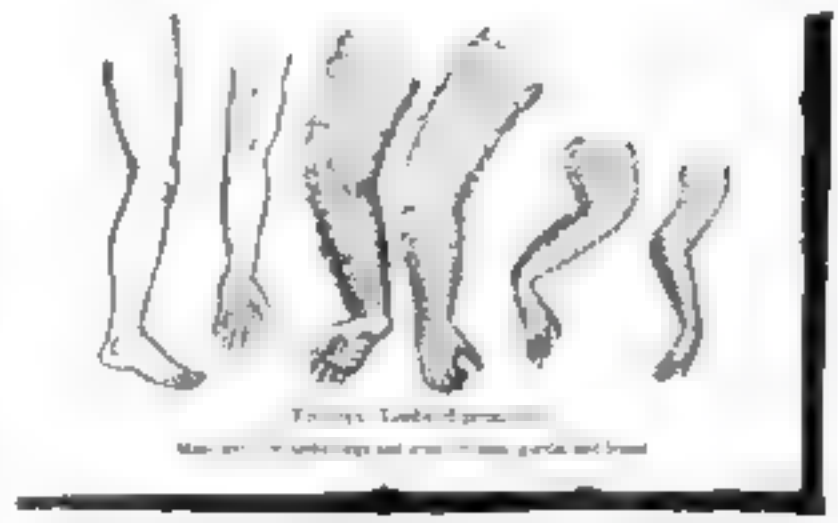
"Contrary to the ideas of some ill-informed people, no scientist has ever claimed that man is 'descended from' an ape or any similar form, neither is there any 'missing link' to be discovered. On the other hand, scientists *do* agree that both man and the apes are descended from a common ancestor from which both the lines have developed. This accounts for the very great similarity in structure."

In the same book, Moon pays signal tribute to Charles Darwin, and calls the theory of evolution "the corner stone of all recent science and the foundation of all modern thought."

In the majority of recent high school textbooks which have been approved under the Arkansas law, the name of Darwin is not even mentioned.

"One of our Arkansas educators wrote to Mr. Moon," Miss Allie Heath, instructor in biology in the Little Rock High School, told me, "and asked him if he would revise his text to make it conform with the law. He replied: 'I will not revise my book to make it fit your legal requirements. I am a scientist, and not a politician.'"

Fig. 1. Anterior limbs of vertebrates

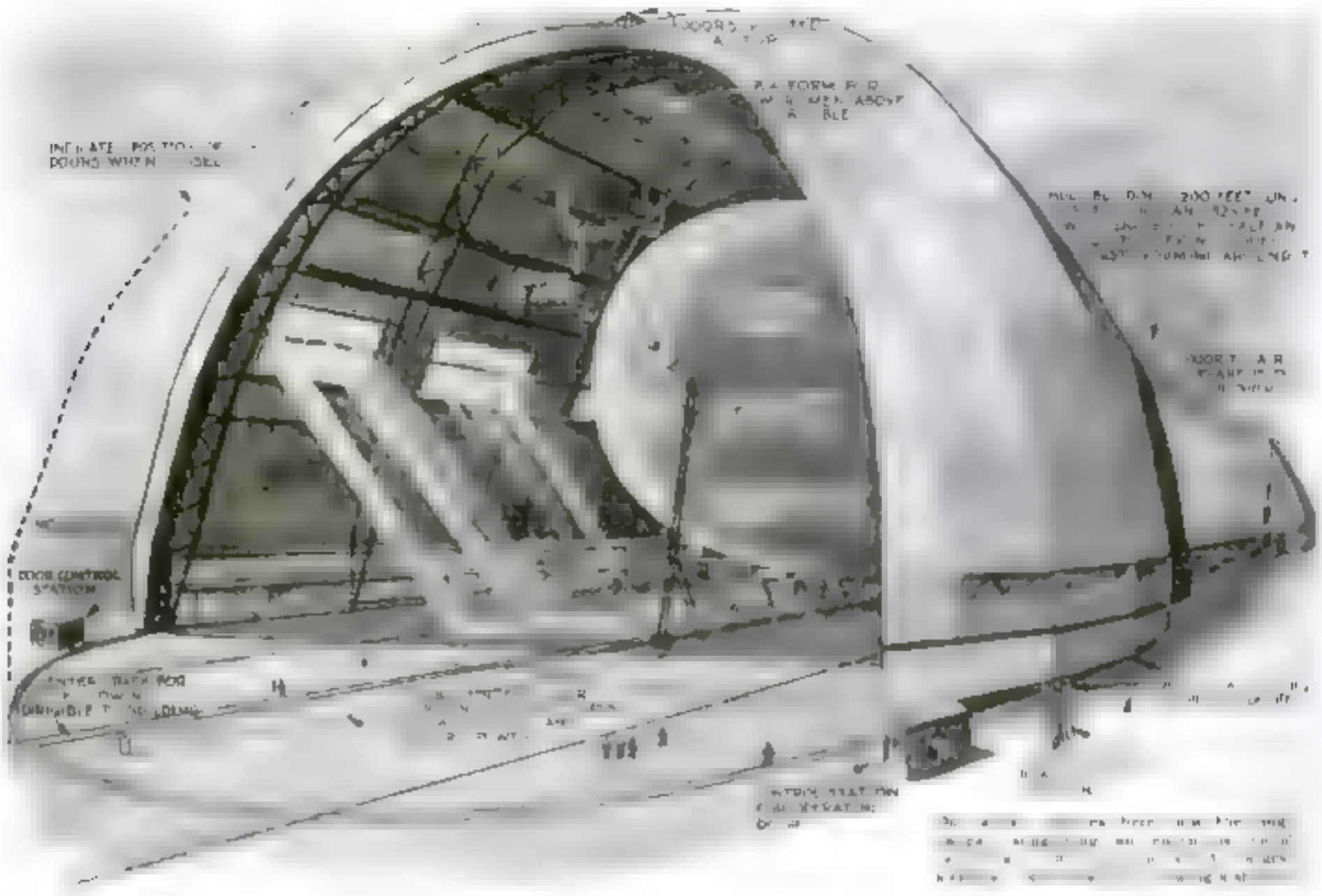


How one textbook author conformed with the law while still presenting lessons in evolution. The lower illustrations in comparative anatomy are from Gruenberg's *Elementary Biology* banned in Tennessee, the upper from his revised book, *Biology and Human Life*. Note wording of caption.

BUT not all writers proved so uncompromising. For example, in the large Central High School at Memphis, Tenn., Gruenberg's *Biology and Human Life* is now used. This book, published in 1925, immediately after the Scopes trial, represents an ideal arrangement for conforming with the law and at the same time presenting the lessons on the theory of evolution.

Biology and Human Life took the place of a book entitled *Elementary Biology*, by the same author, which was banned under the Tennessee antievolution act. Here is an instance of how Mr. Gruenberg (Continued on page 134)

A Nine-Acre Nest for Dirigibles



Mammoth Hangar for the Navy's New Airships Would Almost Swallow the National Capitol!

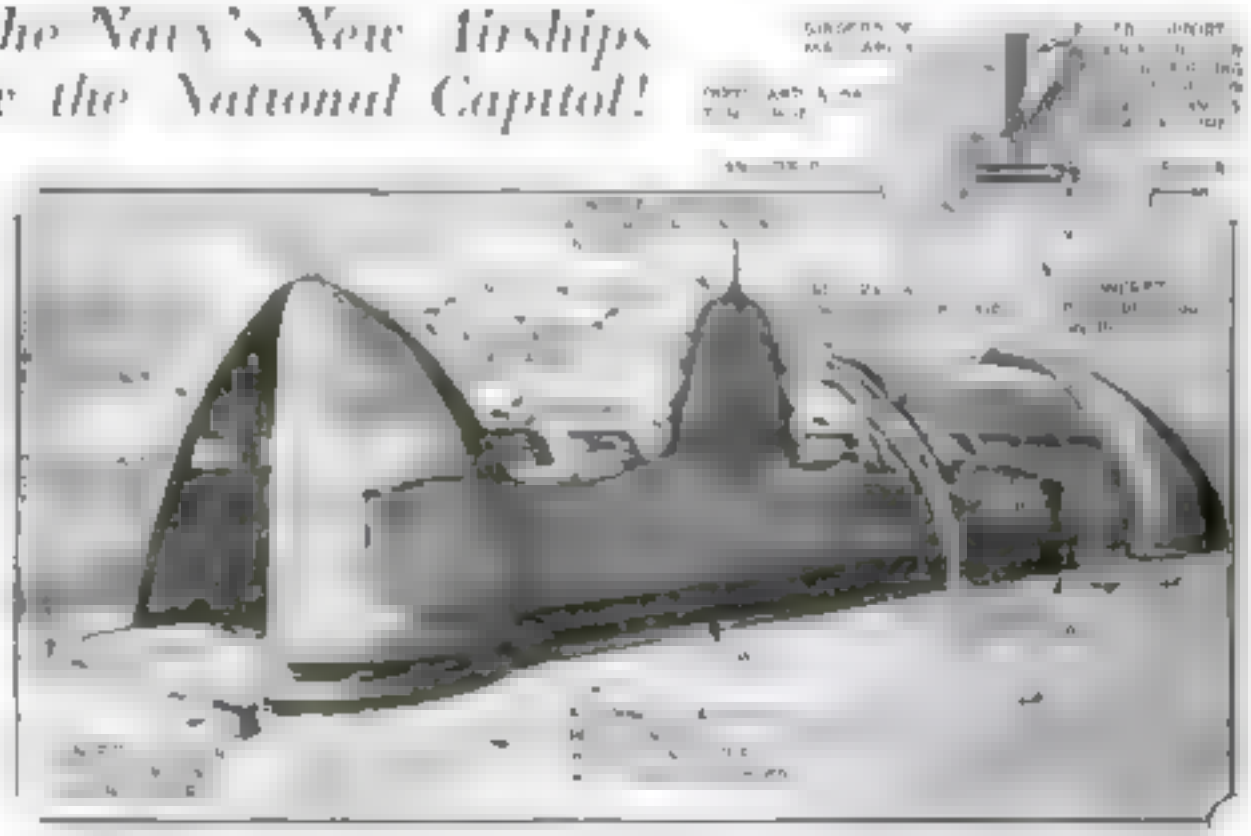
By

ARTHUR A. STUART

WITH the British sky leviathan, the *R 100*, groomed for its flight to America its sister ship, the *R 101* undergoing tests in England, the *Graf Zeppelin* tackling a round-the world trip, and work commencing upon the world's largest hangar at Akron, Ohio, in which are to be built two record-breaking air monsters for the U. S. Navy, public attention again is attracted to lighter-than-air craft

Interest in the United States at present is centered upon the construction, by the Goodyear-Zeppelin Corporation, of the titanic shed in which the two Navy dirigibles, the *ZRS 4* and the *ZRS-5*, will be built and housed. Each of these aerial dreadnaughts will be larger than the *Graf Zeppelin* and the *Los Angeles* combined. Six million five hundred thousand cubic feet of helium will lift each of the immense silver cigars into the air when they are completed in 1933.

Their magnitude is emphasized by comparison with the airships now in existence. The Navy's *Los Angeles*, largest dirigible in America, has a gas capacity of 2,500,000 cubic feet; the *Graf Zeppelin*, latest product of the famous factory of Friedrichshafen, Germany, 3,700,000; and the *R 100* and the *R 101* each 5,000,000. Thus, either of the two American dirigibles will exceed their nearest rivals by a million and a half cubic feet of lifting gas.



The hangar compared in size with the national Capitol. Curious orange-peel doors, each weighing 800 tons, will be moved by motors. Inset shows provision for expansion and contraction.

Besides their great size, the airships will be remarkable for radical innovations in construction. Motor gondolas are eliminated. The control cabin will be the only break in the perfect streamlining of the long hulls. Eight motor compartments

will be located within each airship, the shafts of the motors extending outside to turn the propellers, which can be swiveled to a horizontal position to give an upward thrust when the dirigible is rising, or thrown into reverse in this position to pull down in landing.

AS A protection against attack, these flagships of America's aerial navy each will have machine gun openings at several points in the envelope. Near the center of the bottom of the hull five fighting planes will ride in a "kangaroo pouch" or carrying compartment. A special trapeze device is being perfected to lower them into the air for taking off and to catch them on their return from speedy observation or combat flights. Thus, these remarkable dirigibles are to be flying hangars as well as sky dreadnaughts.

In each main ring of the rigid duralumin framework, ladders will circle the hull and four corridors will lead from one end of the ship to the other, so that inspection of virtually any part of the dirigible may be made in the air. With all eight motors opened up, the giants will speed eighty-six miles an hour. The fuel supply will allow a nonstop voyage of 8,000 miles—the distance an average motorist covers in a year of driving!

While foreign dirigibles use highly explosive hydrogen as lifting gas, American airships employ helium. The United States is the only country now producing an independent supply of this nonburnable, lighter than-air gas.

Before these two mammoths of the sky can be built, a shed big enough to hold them must be constructed. For this purpose, the largest building in the world is rising in the center of a field on the outskirts of Akron, Ohio.

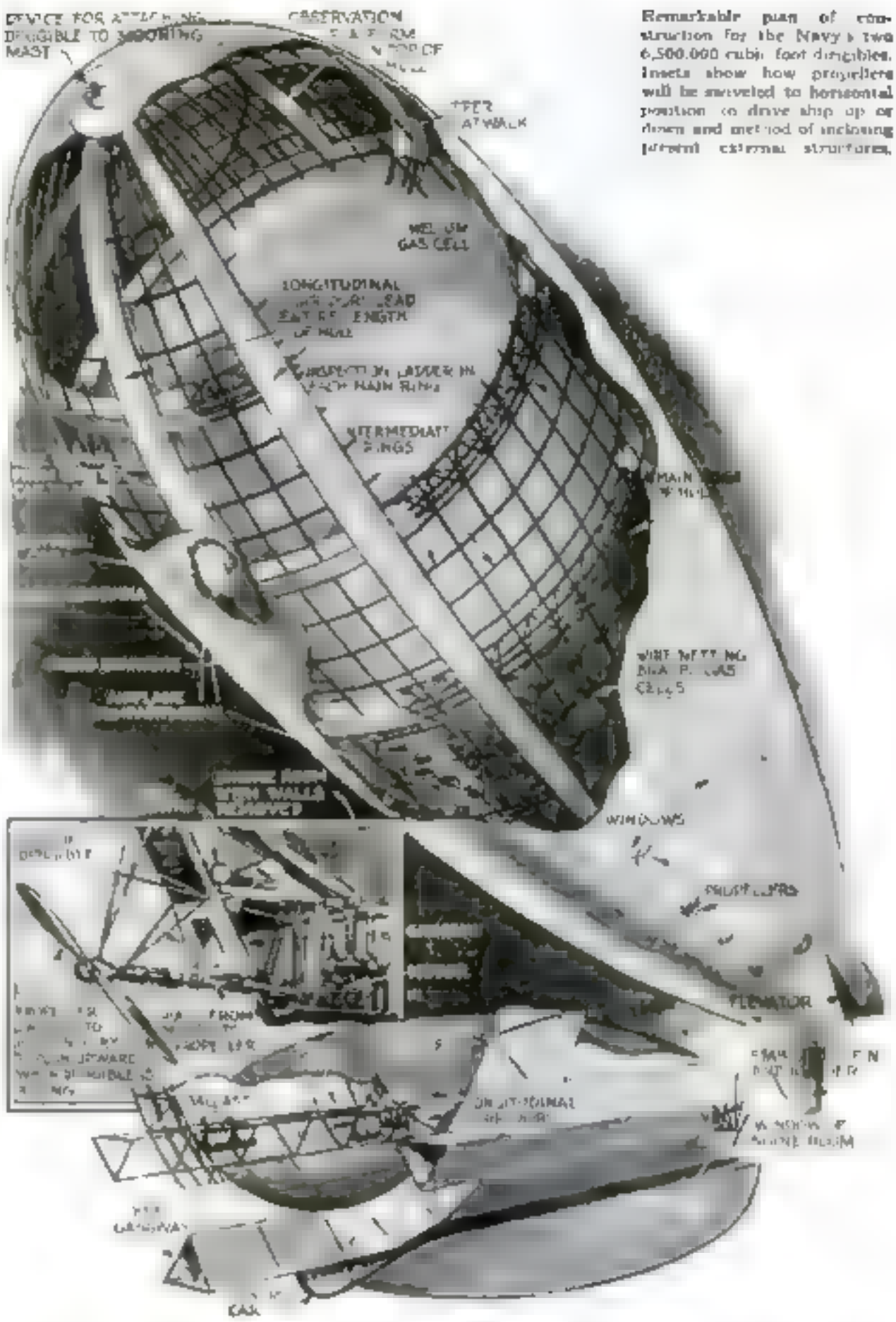
Seen from afar, its fantastic design will suggest a monstrous metal caterpillar. For the sides of the long steel arc to be rounded to prevent the formation of disturbing air currents and sudden wind gusts, such as are created by high vertical walls, and which would make dirigible launching hazardous.

Nine acres of level floor space will be under the single roof. Within the gigantic building fourteen football games could be played at the same time and the whole national Capitol at Washington, except the tip of its dome, would be swallowed up within it! The highest skyscraper in the world, the Woolworth Building, and the Washington Monument both could lie side by side on the floor and leave space for a couple of steamships beside them.

SUPPORTING this mountain of steel, 1,200 feet long, 325 feet wide, and 205 feet high, will be concrete piles reaching to bedrock. The arched design of the building will leave the interior entirely free of obstructing pillars and columns, and will allow working platforms to be placed at various heights up the sides of the walls to permit inspection and repair of the dirigibles while they are "docked."

To preserve the rounded contour of the structure, strange doors, each like the skin of a quarter of an orange, will open and close on semicircular tracks at the ends of the building. Each of the four doors—two at each end—will weigh 800 tons, three times as much as the average passenger locomotive! To move the massive portals, four 125-horsepower motors will be required; and, to slow them down, special electrohydraulic brakes must be applied. The doors will be supported on the tracks by a series of trucks similar to those used on freight cars. Every time the great doors at one end of the building yawn, the opening is 180 feet high and 240 feet wide at the bottom—a space through which a fifteen-story building might pass.

But perhaps the most amazing feature of the design is one that permits the whole structure, with its acres of corrugated steel roofing, to stretch and change its size, to expand and contract with alterations in temperature! This is made possible by placing rollers between the main arches and the concrete supporting piles and by hinging the arches at their bases. Under a blazing midsummer sun, with the thermometer standing at 100 degrees F., the metal building will stretch to a length a foot greater than in zero weather. This constant warping back and forth would shorten the life of the structure if no special arrangement were made to take care of it.



Remarkable plan of construction for the Navy's two 6,500,000 cubic foot dirigibles. Insets show how propellers will be swiveled to horizontal position to drive ship up or down and method of inclosing present external structures.

FUEL, power, and water will be supplied to the various parts of the farmsized floor of the building through an underground tunnel running beneath it. A mile of railway track will pass through the shed to the far sides of the landing field. Upon it will travel the wheeled "land tugboats"—railway trucks to which the airships will be anchored for towing them to and from their huge berth.

While construction of this remarkable dirigible shed is being pushed forward in America, word comes from Germany that a five-million-dollar Zeppelin hangar of radical design is planned. This great airship shed is to revolve on a turntable so it can be pointed to avoid cross winds when sky liners leave or approach its doorway.

Cheaper Power from Quicksilver

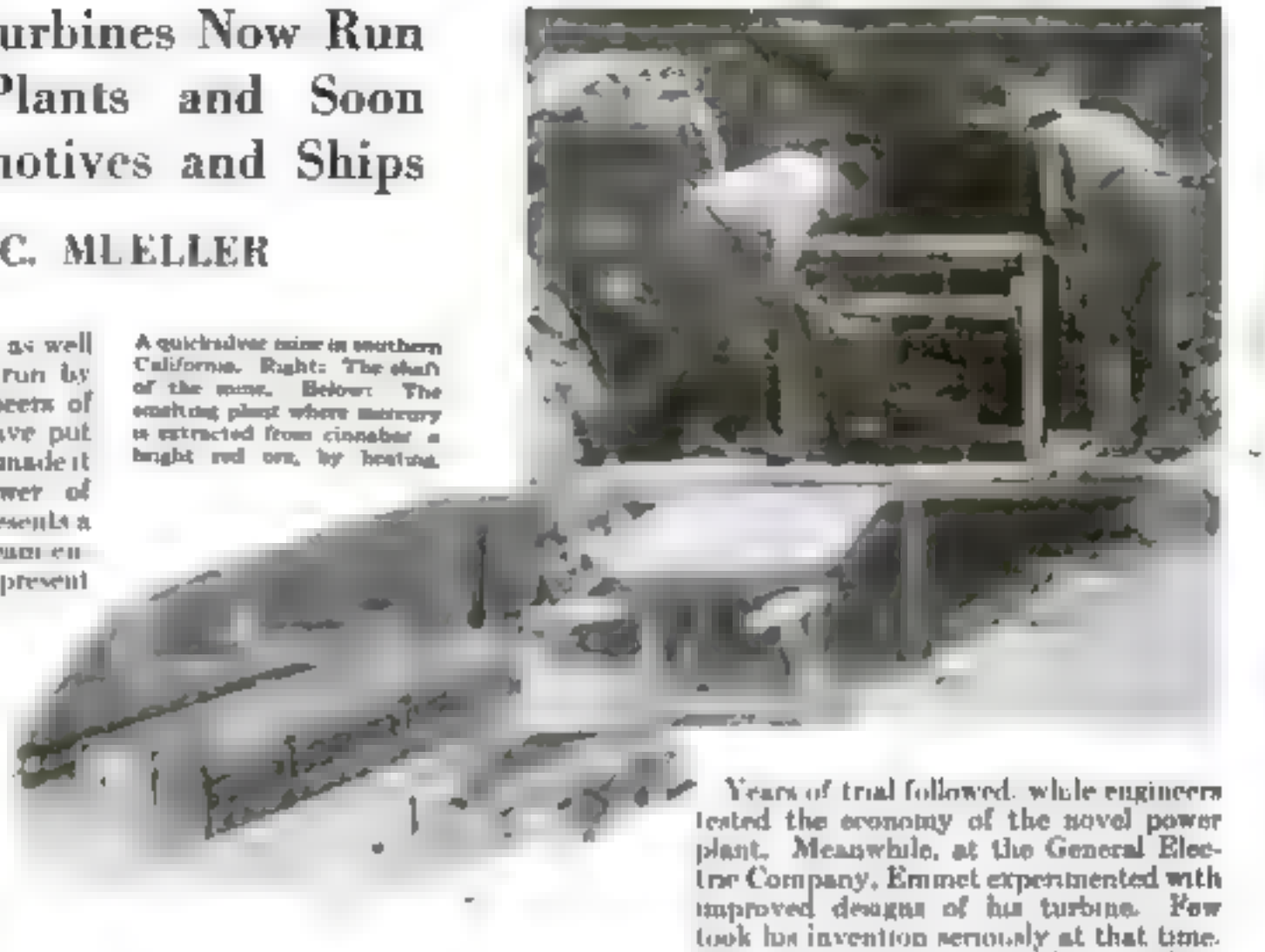
Mercury-Vapor Turbines Now Run Electric Light Plants and Soon May Drive Locomotives and Ships

By GROVER C. MUELLER

SOON locomotives and ships, as well as thermometers, may be run by quicksilver. Already engineers of an Eastern power plant have put the fluid metal in their boilers and made it generate about 15,000 horsepower of electricity. The mercury boiler presents a powerful potential rival to the steam engine and may revolutionize present methods of producing energy.

That is the situation described by Alfred D. Flinn, director of the Engineering Foundation, of New York City, in a recent report on actual commercial production of electricity with the "mercury turbine" by a Hartford, Conn., electric light company. Patterned exactly after the familiar steam turbine of commerce, it uses the vapor of mercury instead of steam to drive its whirling blades. Important savings in fuel and money are said to result.

The "steamless steam turbine" in the Hartford company's South Meadow power plant looks somewhat like an ordinary steam turbogenerator, but sounds very different. Inside the shell which encloses it, the turbine shaft makes twelve revolutions every second, yet there is scarcely a sound, and vibration is absent. A man standing near it can hardly tell when the turbine is running.



A quicksilver mine in southern California. Right: The shaft of the mine. Below: The crushing plant where mercury is extracted from cinnabar a bright red ore, by heating.

Through the whirling blades of the turbine courses the vapor of mercury, a poisonous cloud heated to 884 degrees F., from boilers fired with pulverized coal on the floor below. Behind the turbine and the electric generator to which it is coupled is a huge cylindrical tank, a condenser that recovers the valuable mercury after it has driven the turbine. Its work is not yet done. It gives up the rest of its heat by turning water into steam, and there is enough power left to run a conventional steam turbine.

There is the secret of the mercury turbine's efficiency. Mercury vapor is so much hotter than steam that its energy can be used over and over again before it cools enough to be useless. In the South Meadow plant, engineers estimate that that means a fuel saving of $200,000 a year.

Credit for the invention of the mercury engine belongs to William LeRoy Emmet, General Electric Company research engineer, who first proposed in 1914 that mercury could be used to drive a turbine wheel and later constructed an experimental machine at the company's Schenectady plant. In 1923 the first mercury-vapor power plant in the world was installed in the Dutch Point plant of the Hartford Electric Light Company. It was an experimental outfit of less than 5,000 horsepower, developing nearly half of its power from a single-wheel mercury turbine and the rest from the by-product steam used in a steam turbine.

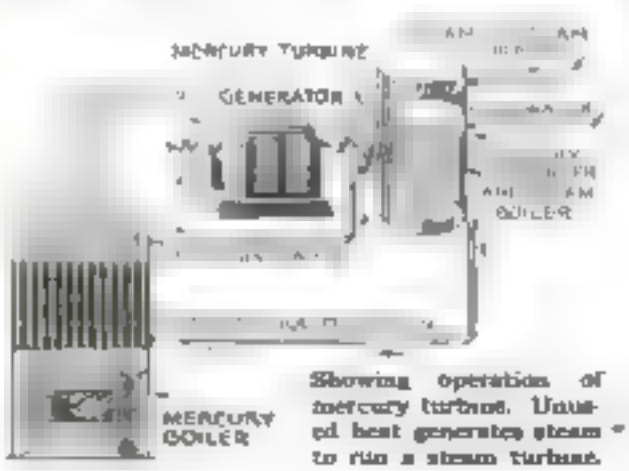
Courtesy Electrical World.

The first installation of a commercial mercury vapor turbine in power plant of Hartford Electric Light Co.

Years of trial followed, while engineers tested the economy of the novel power plant. Meanwhile, at the General Electric Company, Emmet experimented with improved designs of his turbine. Few took his invention seriously at that time. They said that, even should his machine prove a success, there was not enough mercury in the world to run his turbines. As an answer came the order of the Hartford company for a huge new mercury turbine of 13,000 horsepower for full commercial service, at its South Meadow station. It was completed in November of last year, and gave uninterrupted service until it was recently dismantled for further engineering improvements.

NEARLY seventy tons of mercury are required to run this plant—more than a thousand gallons. With mercury at the current price of about $200 a gallon, a fortune in liquid metal lies within the boiler's tubes. Should a tube leak, $200,000 worth of mercury might trickle away. For that reason, packed joints are out of the question. Arc-welded pipes guard the precious liquid, to avoid its loss and to keep the poisonous fumes from escaping.

So far the mercury turbine has been tried out only in electric power stations. The inventor sees no reason why it should not be applied to locomotives, and to ships, as well.



Showing operation of mercury turbine. Unused heat generates steam to run a steam turbine.

Interior of a cigar store in New York City, showing customers at the left purchasing their cigarettes from automatic coin-in-the-slot salesman.

Talking Robot Sells Flapjacks

Apples, Root Beer, Cigarettes, Gasoline, Candy, Radio Also Dispensed by Automatons Eggs with a Cackle Next

By

FREDERICK TISDALE

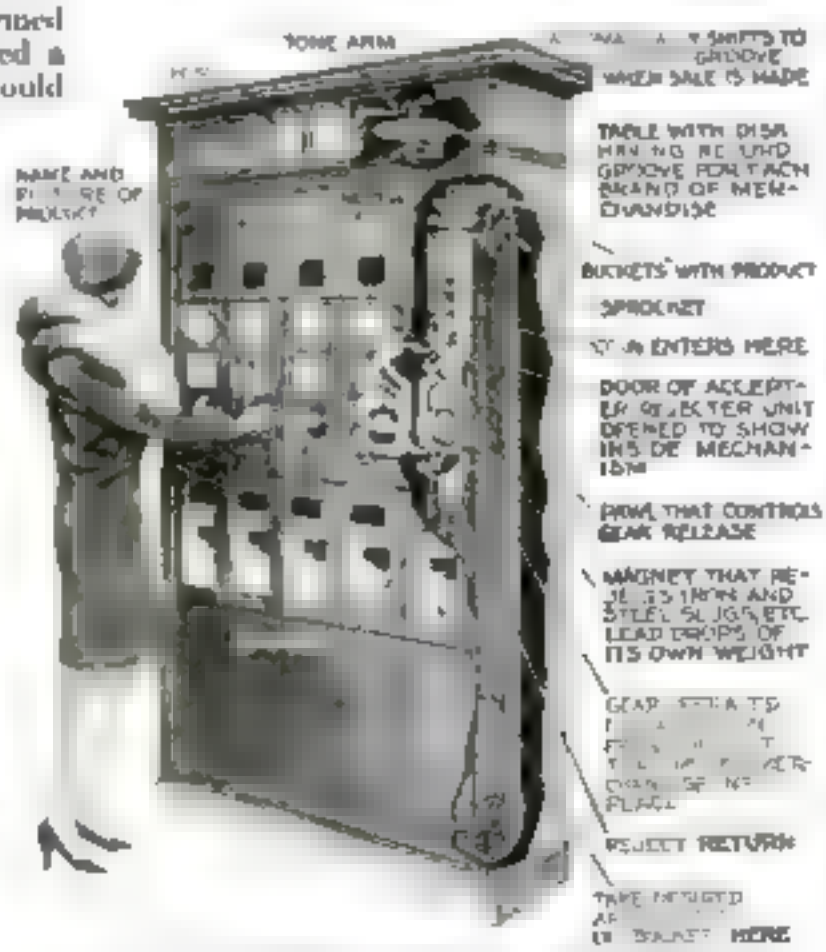
A DARK young man with a restless eye sauntered into a store at Forty second and Broadway, New York. Sidling up to a change machine he was informed by the directions that if he dropped a quarter in a certain slot, five nickels would be delivered below. The dark young man drew something from his pocket and inserted it hastily at the point indicated.

The change machine accepted the disk with a noncommittal click. Instead of disgorging five nickels, it dropped an iron washer into the delivery cup, and from within the cabinet a stern voice spoke:

"Please use good coins only."

For a moment the young man regarded the machine with sagging jaw, then took the rejected washer and beat a hasty retreat.

This small-time fraud was exposed by the latest machine to join the army of selling robots now serving the American public. The inventor, Joseph J. Schermack, declares it will refuse anything but honest coin. During the second it takes for a quarter to go through the machine, the coin is submitted to a merciless third degree. First it is tested for weight. Then it passes to the chief detector, which is an electromagnet. True coins are not halted, but any disk containing fraudulent metals is drawn aside into a channel which rejects it. In passing, the guilty slug forms an electric contact which starts a disk phonograph in the top of the cabinet. The voice is recorded on a single groove. When the revolution is complete, the contact is broken and the record stops.



A battery of five cigarette vending machines, broken away to show operation. Its "voice" comes from phonograph at top.

This is not the only slot machine to be given a voice. Schermack previously had developed a space-saving automatic vending machine for a national chain of cigar stores. The first model was installed in a store on Broadway. It was efficient but inarticulate. One day the inventor overheard a customer say:

"IT'S a slick machine all right. But I miss the 'Thank you' that you get from a human salesman."

Schermack seized upon the idea. The result is a type of vending machine that soon will be competing with clerks all over the world. "Robot salesmen," as they are called, now sell any number of package commodities and speak

One of eleven slot machines in a New York "Sodarest" which dispenses root beer, orangeade, and other refreshments.

some form of benediction as they deliver the purchase. The merchandise is placed in buckets that move on an endless chain. The smallest models have eighty-five buckets—which means they can make that many sales without refilling. The chain is moved by a sprocket which the patron turns with a handle when his coins trip the release.

Suppose you have three nickels with which you wish to buy a package of your favorite cigarettes. You drop one after another into the slot. Each nickel follows a channel until halted in a pocket where it pushes back one of a number of pawls that prevent the handle from turning. All three nickels must find their places before the pawls are released. You can now move the handle, which brings a loaded pocket to an opening where you may reach the cigarettes.

AS IN the change machine already mentioned, the turn of the handle closes an electric circuit and starts the phonograph in the machine. The first robots had scant vocabularies, contenting themselves with a hearty "Thank you." Now the thanks is followed by such famous trade slogans as "They're toasted," and "Not a cough in a carload." One of the machines will speak its short piece 10,000 times before wear makes necessary a fresh record.

It's pretty hard to put anything over on this robot. Pennies, being smaller than nickels, slide through without releasing the pawls; iron or steel slugs are pulled into an exit groove by a common horseshoe magnet; lead slugs drop into the same channel because of their overweight. All the mechanism swings outward like a door, which makes refilling and service a simple matter. A meter, visible from the outside, registers the amount of the sales.

The voice device has been applied to machines selling many sorts of cosmetics, candies, and food products. A proposal now being considered is for an egg-selling machine with a cackle.

The talkie slot machine has not been a success in every field. Take the case of the talking scales. Experiments with a machine that announced your weight when you dropped a coin surprised everyone when it took in far less money than its silent brothers. Investigation disclosed the trouble. A woman whom the fashion papers would call a "stylish stout" stepped on the speaking scale in a store and surrendered a coin. There was a whirring noise and a voice announced to the world

"Your weight is one hundred and ninety-five pounds."

SMILES and lifted eyebrows on the faces of other customers. The fat lady flounced out indignantly. No woman living will submit to a public announcement of the fact that she weighs a hundred and ninety-five.

The conversational machines mark a far advance over the primitive slot vendors. It is said that the chewing gum industry had its inception when the famous Mexican, Santa Ana, gave Thomas Adams a piece of chicle and told him to chump down on it. Descendants of this historic chew now soothe nerves and gum up shoe soles wherever Americans walk the earth. Some forty years ago this same Adams hired a German mechanic to construct a machine that would produce a tab of gum when its "innards" were animated by a penny.

That primitive slot machine was simple but it worked. The same may be said of many of its children. In the mirrored boxes which cling to posts in railway stations and elsewhere, tabs of gum and confections are loaded in chutes. Operation is by gravity. Often a lead weight is placed on top to aid in forcing the packets downward. The dropped coin releases a slide on which the bottommost tab lies. As the slide is pulled out the tab drops. A spring carries the slide back to its original position. Sometimes this type of machine fails to work because the packets have become so depleted that those remaining have not weight enough to force the lowest into its proper position.

A new automatic radio slot machine and its inventor Joseph Pinto. Designed mostly for installation in hotels, it gives fifteen minutes of radio programs for a quarter. You tune the set yourself to the station you want.

Deposit a coin and this robot will polish your fingernails. L. W. Schaaf, left, is the inventor.

Automatic scales are as multitudinous as gum machines. There are hundreds of types, ranging from the breed which prints your weight on the same card that tells your fortune to battered old veterans with clock faces. The experience of the Woolworth stores with penny scales gives some idea of how powerful is the public's urge for weighing. There are 3,000 penny scales in something less than 2,500 of these stores, giving a net profit of $375,000 in a year. During the day the scales are inside with the customers; as soon as the doors are locked

(Continued on page 158)

Now—Television in Natural Colors

By ALDEN P. ARMAGNAC

COLOR television is here, at least in the experimental stage. In the darkened auditorium of the Bell Telephone Laboratories in New York City the other day, a young woman wearing a colored dress sat before a cabinet of frosted glass—part of a new radio vision transmitter developed by Dr. H. E. Ives and his associates in the Laboratories. A narrow beam of light from a powerful arc lamp flickered across her face and figure so rapidly that it seemed to observers as if she were bathed in a steady glow of light.

At the opposite side of the auditorium, in a separate chamber, Dr. Ives peered into a telescopelike window. Through a frame scarcely larger than a postage stamp he saw the young woman, startlingly lifelike, with the color and pattern of her costume perfectly reproduced. Now she held up a ball of yarn, and its crimson hue was instantly visible in the peephole receiver. Other observers took turns at the magic window. They saw, in turn, an American flag, the Union Jack of Britain, a flowerpot of geraniums, each of the objects, in its distinguishing colors.

In this first demonstration of transmitting and receiving instruments for television in color, the images were sent by radio across the auditorium. The feat was accomplished by a modification of the principles on which all television—the art of seeing moving objects at a distance—is based. Suppose a beam of light falls on a bright object, and, reflected, illuminates an electric "eye," or photo-electric cell. The light permits electric current to flow through the cell. This current, transmitted by wire or radio, will light another lamp in a "receiving" television machine. But if the original beam of light is trained upon a dark object, little or no light is reflected. The electric cell does not pass a current. At the receiving end the lamp does not light.

IN TELEVISION the first beam of light, from an arc lamp in the transmitter, constantly zigzags back and forth across the face of the subject. Similarly a beam from the lamp at the receiving end is made to zigzag, exactly in step with the other, across a screen. So rapidly do the beams of light scan the entire picture, a streak at a time, that you seem to see the whole scene at once, recreated in black and white.

There were seemingly insuperable obstacles that stood between "black-and-white" and "color" television. Dr. Ives and his engineers conquered them all by inventing first, an electric eye sensitive to light of any color (most electric eyes are color-blind to red); then lamps that would glow in other colors than the pinkish-red of a tube filled with neon gas; and finally, a way of transmitting and combining three pictures of a distant scene at one time instead of just one.

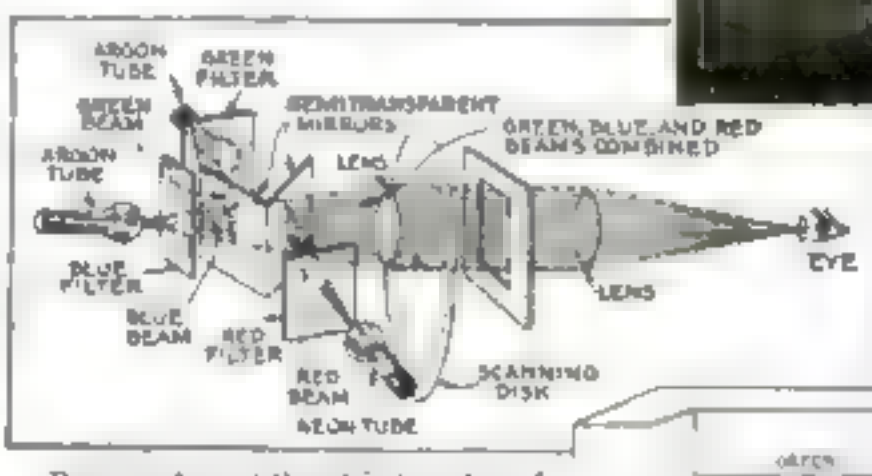


Diagram showing the intricate system of lamps and color filters used with the scanning disk in the receiving apparatus.

The transmitting cabinet, showing red, blue, and green filters screening twenty-four photo-electric cells.

At the transmitting end. The subject, seated before a cabinet of frosted glass, is scanned by a moving beam of light.

Photographers and color engravers know that with only three so-called primary colors it is possible to reproduce all the hues of a given scene. They make three pictures, each through a "filter" of glass or gelatin stained with one of those colors, of the colored object to be reproduced. When the three pictures are combined the object appears in its original, blended colors.

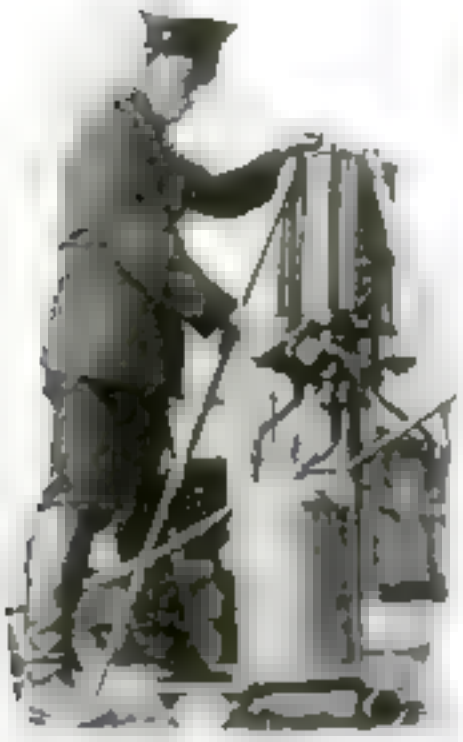
Color television receiving apparatus, with door of cabinet opened. The transmitted scene is viewed through the eye-piece at the right.

This same method now is applied to television. A girl, for example, sits before a cabinet, a beam from an arc light coursing over her. Behind panes of frosted glass are twenty-four electric "eyes," silently watching. Fourteen of them, screened by panes of red stained gelatin, are picking out the red spots in her dress and the tint of her cheeks. Eight others with green "filters" record the green pattern in the fabric, while two others with blue filters keep tabs on her blue eyes and anything else of a bluish tint in the scene. All three impressions are broadcast continuously and simultaneously, but on different radio channels or wave lengths.

At the receiving station three radio receivers, properly tuned, pick up the separate impulses of the red, green, and blue pictures. Newly devised lamps filled with argon gas reproduce the green and blue light with the aid of colored screens of those colors. A conventional neon lamp with a red filter used in front of it supplies the red parts of the picture. Through partly-transparent mirrors, the three lights are combined in a single beam.

The net result is a moving pencil of light that changes color, like a chameleon, to match the color of a spot touched by the arc lamp's beam in the sending machine.

Forward Strides in Aviation



Mixing chemicals in a new fog making machine developed in Germany to screen military centers from enemy airplanes. It produces artificial fog, shown below.

A. Sidney Dawes, president of a construction company in Montreal, Can., uses this sportly plane equipped with pontoons, to make the most of week-end hunting or fishing trips. The photograph shows him with the machine after alighting on a wooded lake in the heart of northern Quebec

A special precision tool born of the airplane industry. It is being used for the delicate job of reseating a valve on an airplane engine. Two cutters mounted on the tool's main shaft center the work precisely for reamers to cut the tough bronze seats.

Marcel Minguet, a French engineer, with new short wave radio apparatus he has invented to enable flying travelers to phone or telegraph friends on the ground. The messages, picked up by ground receiving sets, are relayed to their destinations over telephone wires. He claims that telephone calls can be made to within a radius of 1,200 to 1,500 miles; telegraph messages to 6,000 miles.

A test of the new chemical fog making machine. A squadron of German army planes, setting out to "bomb" a factory, was met by drifting banks of artificial clouds which obscured the factory and the surrounding land. The pilots were helpless.

Machines nearing completion in the main assembly line of one of America's largest airplane factories, the Boeing Airplane Company plant at Seattle. Here nearly 1,000 employees work night and day in three shifts, turning out planes of many types, from small fighting ships to huge air liners.

Laughing Moth plane *Youth of Britain* built for Sir Alan Cobham, England's famous "sky taxi man," for good-will tour.

A New 1,400-Mile Beacon Protecting Our Cities from Air Attack—Notable Flights and Inventions

REACHING out 1,400 miles, a new radio beacon at Mitchel Field, N. Y., guides pilots who are flying "blind" in fog or darkness safely to the Army airport. During daylight, the beacon has a radius of 400 miles.

The pilot who approaches the beacon in thick weather is led by a band of wireless signals. As long as he stays in the center of this band the signals are strong, but if he wanders from his course and flies to one side or the other they become dim. By keeping in the center of this invisible beam he is guided straight to the field.

How valuable such beacons can be is illustrated by the experience recently reported by an Army pilot. He flew several hundred miles, all of the time above the clouds and out of sight of the earth. When he spiraled down through the clouds where the beacon indicated the airport should be, he found himself directly above it.

Air-Rail Lines Open

FOURTEEN passengers recently arrived at Los Angeles, Calif., completing the first regular transcontinental air-rail trip in sixty hours. Their mixed voyage from New York by train, airplane, and another train marked the opening of the first of several such services.

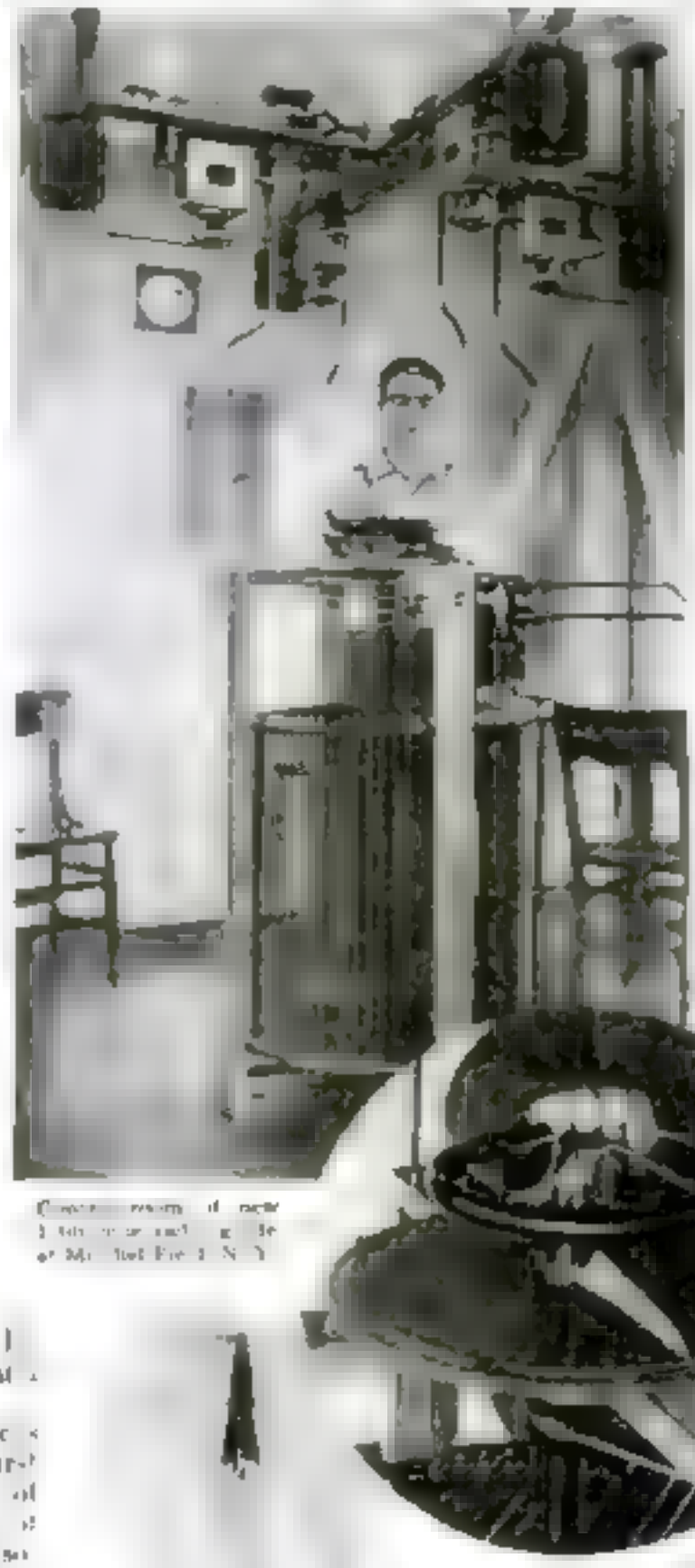
On this "Great Circle Route," as it is unofficially known, the Universal Aviation Corporation operates planes between Cleveland, O., and Garden City, Kan. The rest of the transcontinental trip is made by trains of the New York Central and Santa Fe Railroads.

Other transcontinental air-rail services ready to begin operation when the first one was officially opened were those of the Southwest Fast Air Express and of the Transcontinental Air Transport soon called "Lindbergh Line," for which a year's preparations had just been completed. Each of these schedules a forty-eight hour trip from coast to coast.

New Cross-Country Record

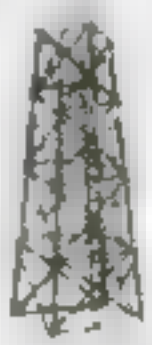
IN NEW YORK one night, in Los Angeles the next, and back again in New York by the next bedtime—that was the amazing record recently hung up by Capt. Frank Hawks, the fastest transcontinental traveler in history. He took off early in the morning in his speedy plane from New York City, and landed at Los Angeles nineteen hours and ten minutes later. He had bettered by more than five hours the previous east-to-west transcontinental record of the late Capt. C. B. D. Collyer and Harry Tucker.

Adjustments to his plane delayed his return for seven hours. Then Hawks hopped into the cockpit, pointed the swift craft toward New York, and "gave her the gun." He arrived in seventeen hours and thirty-eight minutes, bettering the west-to-east record of which he was already the holder. In the final landing Capt. Hawks, hampered by darkness and fatigue, crashed through a wire fence but was unhurt.

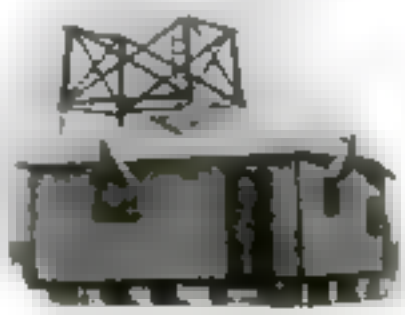


Control room of new radio beacon at Mitchel Field, N. Y.

Otto Praun, control engineer, now beacon operator, is setting the course of a pilot. Arrow points to loop aerial



Towering aerial mast above the Army radio station at Mitchel Field, N. Y.



Taming "Flat Spin"

TAKING the peril from the dangerous "flat spin" of airplanes out of control—and even putting the spin to practical use—is the latest object of the National Advisory Committee for Aeronautics. At its Langley Field, Va., laboratory it has constructed a new wind tunnel of unconventional design, a vertical instead of a horizontal tube through which air blasts howl.

Already, as a result of movies made of model planes in this tube, engineers have blamed improper distribution of weight. In consequence it is now possible to design planes that cannot spin. Some engineers, however, suggest that a military pilot might use the maneuver to escape from a dangerous position in the air. Further investigations may show how to control the spin, if it is not desired to prevent it.

Dirigible Line to Hawaii

RECENTLY arrived in Los Angeles, Calif., the 128-foot dirigible *Explorer* is to make daily flights to study weather conditions. The information is to be used by pilots of giant 100-passenger airships that may ply between the United States and Hawaii within three years.

By 1931 or 1932, dirigibles twice the size of the *Graf Zeppelin*, Germany's air leviathan, will open a regular air route from California to Hawaii, according to Dr. Karl Arnstein, vice president and chief designer of the Goodyear-Zeppelin Corporation. A fleet of these air monsters, he declares, can be operated more cheaply than a fleet of steamships, due to their speed, and they will carry passengers at a lower fare. Eventually it is planned to extend the projected trans-Pacific service to Japan.

From Maine to Spain

LOST two hours in fog over the ocean, three French aviators found their bearings in time to blaze a new trail across the Atlantic. Their achievement in reaching Comillas, on the northern coast of Spain, less than thirty hours after leaving Old Orchard, Maine, ended

fears for their safety when they failed to appear in Paris, their announced destination.

The brave trio, Jean Assolant, Rene Lefevre, and Armeno Lotti, Jr., fought unlucky odds from the start. Hardly had they left Old Orchard when an American stowaway, Arthur Schreiber, was discovered on board. Rather than risk another take-off they continued with the unwelcome passenger, whose extra weight upset their careful calculations as to fuel load and food supplies. They considered themselves fortunate to make a forced landing, with fuel nearly exhausted, on the shores of Spain.

$13,000,000 Plan for Air Defense

EVERY important American city will be fortified against possible air attack in a re-armament program drafted by the General Staff of the Army for presentation to Congress at the December session.

A minimum of $13,000,000 will be asked to start the project, which, it is estimated, will take five years to complete.

If the program is approved as expected, the crack of three-inch guns and the stutter of antiaircraft machine guns in practice may become as familiar to city residents as the backfire of automobiles.

For ten years since the war, Army ordnance experts have been working to improve antiaircraft weapons. The latest guns are so accurate that the attacking airplane's chances of safety have been reduced to a fifth of what they were during the war.

A highly developed three-inch gun, capable of bringing down bombing planes at a great altitude, will have the chief responsibility of protecting American cities. No airplane can fly at an altitude greater than the range of this weapon, experts say.

This gun will be supported by various new weapons, including a combination of four machine guns on a single mount, which can be operated and aimed almost as easily as turning a stream of water on an object fifteen or twenty feet away. It can set up a wall of bullets at the rate of 3,000 a minute.

Backing these weapons will be mechanical eyes and ears, which can spot attacking enemy planes more than five miles away, and a new range finder, which automatically trains the guns while the operator follows the speeding airplane target with a telescope.

The necessary firing data for the guns is computed automatically by the sensitive director, a calculating machine which, if kept directed at the target by means of a double telescope, also will m

U.S. Army's new weapon against [illegible] Above [illegible] guns to bring down bombing [illegible] Top: Larger antiaircraft [illegible]

dicate continuously the elevation and direction at which the gun should be set.

All of the new weapons and detectors have been developed secretly in Army arsenals, but have been openly tested to the satisfaction of military authorities.

The primary purpose of the plan is to protect all vital industrial districts, railroad centers, and other strategic points open to attack from the air.

Millions of Miles Flown

SOME idea of the distance flown by American planes is revealed by figures recently made public on the second and third birthdays, respectively, of two great American air lines.

One line, completing three years of operation between New York and mid-western cities, says its planes have flown a total of 4,700,000 miles, of which more than a third were covered at night. Today its planes fly 5,500 miles daily.

Another line, operating the western half of the transcontinental air mail route, boasts of a record even more remarkable. After only two years of operation its planes have flown 5,000,000 miles, and now cover 10,000 a day. They soar from sea level to a height of 12,000 feet, in temperatures from thirty-five degrees below zero to 135 above.

A $70,000,000 Air Merger

FORMATION of a $70,000,000 firm to manufacture airplanes and motors is the latest event that indicates aviation is to progress rapidly under the impetus of "big business." The new concern merges two huge airplane manufacturing companies, a great motor making organization, and nine affiliated businesses. It is the largest aviation holding company in America.

Already two other industrial giants have entered the airplane field—one a $35,000,000 concern formed early this year, the Aviation Corporation, and another $25,000,000 firm, the United Aircraft and Transport Company. In the latest merger the Curtiss Aeroplane and Motor Company's plane-making factories are linked with the motor plant of the Wright Aeronautical Corporation. With the Keystone Aircraft Company and other firms, they become the Curtiss-Wright Corporation.

Huge Magnet to Clean Airport

A GIANT magnet propelled by a tractor recently has been obtained to remove numerous particles of wire and nails from the runway of an El Paso, Texas, airport. When it is driven across the field scraps of metal half-buried in dust leap upward and cling to the end pieces of the magnet, from which they are easily removed by hand at intervals.

Open Hudson Air Line

JUST nineteen years after Glenn Curtiss stood in a field near Albany, N. Y., watching puffs of cigar smoke to be sure that no air was stirring before starting his famous Albany-New York flight, a regular, rain-or-shine passenger service between those two points has been established. Cabin seaplanes follow the course of the Hudson River.

Seven Rules for Safety

WHILE the Daniel Guggenheim Safe Aircraft Competition at Mitchel Field, N. Y., was getting under way with the first entrants listed, Harry F. Guggenheim, president of the Daniel Guggenheim Fund for the Promotion of Aeronautics, announced seven cardinal rules for air safety. Any air line worthy of patronage, he declared, should possess the following attributes:

- Multi-engined planes that can fly with one engine disabled.
- Two Government licensed pilots for each plane.
- Planes and engines all licensed by the Government.
- Adequate landing fields all along the route.
- Intensive weather reporting service from start to finish.
- Radio or visual communication between plane and airway.
- Responsibility of air line operators.

The "safe aircraft competition" has as its object the selection of "fool-proof" types of planes.

AMERICA now builds three times as many planes as any other country in the world. These pictures give the latest news of progress.

Grover C Loening noted plane designer with his latest creation an all-metal amphibian with one supporting wheel during a test at Roosevelt Field N Y

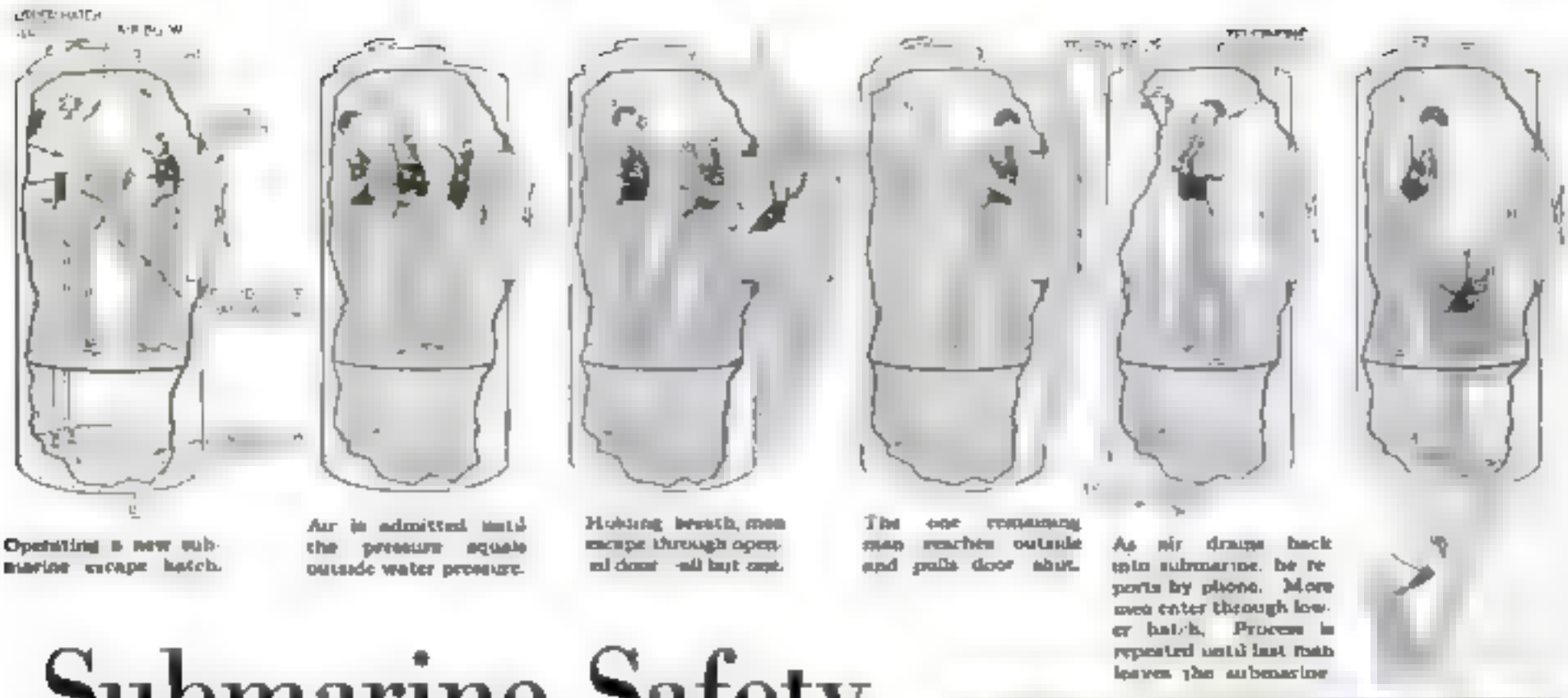
They wanted a plane so these boys and girls in posts [illegible] at Wanamaker's They Pioneer Type Flying Art at Annex [illegible] of New York City and, each evening work on the plane.

Above A squadron of Army planes taken during a recent maneuver of Army planes at the Tanforan Aviation Field at Stanford over Crissy Field San Francisco Bay Nearing shown thousands of which the planes are flying in [illegible] with their wing tips almost grazing

Left A practice attack of Navy bombing planes The huge machines are seen flying in battle formation over a submarine mother ship and a destroyer at anchor near San Diego

A sticky flypaper landing field equipped with electromagnets that attracting planes to their own length has been devised by Walter Link of Washington D C shown above Magnets pull back on the plane's metal tail skid.

F W Dickinson of the U S Bureau of Standards with device he has invented for detecting errors in directing radio beacons. Dial above his head shows error.



Operating a new submarine escape hatch.

Air is admitted until the pressure equals outside water pressure.

Holding breath, men escape through open manual door—all but one.

The one remaining man reaches outside and pulls door shut.

As air drains back into submarine, he reports by phone. More men enter through lower hatch. Process is repeated until last man leaves the submarine

Submarine Safety Devices Proved

By ALFRED P. RECK

A MAN in a bathing suit stood before the air-tight covered diving tank at Washington Navy Yard. Strapped around his middle was a flat bag, similar in appearance to the war-time gas mask container. Two tubes emerged from the top of the bag and their ends he gripped in his mouth. There was nothing over his nose or face

The diver nodded a signal and ducked into the tank

Observers above saw the needle of a pressure gage quiver around thirty three pounds the ordinary atmospheric pressure then throb upward as if recording the action of an erratic heart

Sixty-seven pounds

"That's equivalent to 150 feet under the surface," a naval officer explained as he watched the gage closely

Under the surface? Nothing but air surrounded the "diver" in this strange tank. Yet compressed air that had spurted in gave exactly the same effect as if he had been 150 feet below the sea waves. The tank had been built for the express purpose of simulating, on dry land, all the conditions and sensations a diver might experience under the water

Seventy pounds eighty one hundred

Motors operating the air compression tanks hummed. The needle pulsated higher and higher

One hundred and eleven pounds

"That's [illegible] feet under the [illegible]

[illegible] needle

[illegible] ured

[illegible] sure

[illegible] nch

Could the d[illegible] side

The steel walls that

The "lung" proves its worth. Lieutenant Momsen reaches surface from submerged S-4, using his invention.

In the flooded motor room of submarine S-4, submerged 200 feet off Key West, Fla., Lieut. C. B. Momsen dons his new "lung" before escaping through overhead hatch.

tank withstand such terrific pressure against his unprotected body?

Some one hurriedly figured it up. About 200,000 pounds—139 tons, the weight of a giant locomotive—was pressing against him

STILL the needle climbed. At 133 pounds it stopped.

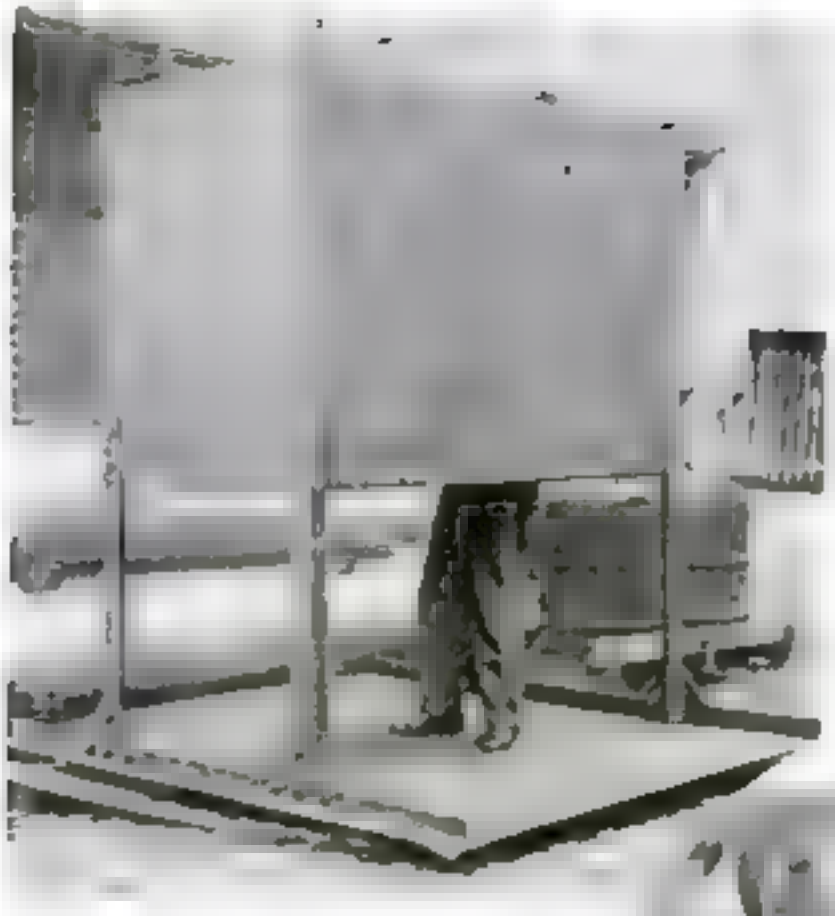
"That means he is 302 feet below the surface," the officer remarked.

No human being ever before had gone that far under water without the protection of a diving suit and very few even with a steel helmet

It had taken seven minutes to build up pressure equal to 302 feet in depth. Decompression, necessarily, was much slower. Nineteen and a half minutes after the needle started dropping, Lieut. C. B. Momsen—the diver—stepped out of the tank. In all that time his head never had been a foot below the surface, yet he had proved a man could stand the pressure fifty fathoms down and come out alive.

He also had proved a far more important thing to the Navy—the value of the breathing "lung" in escapes from crippled submarines. For it was this "lung," strapped around his middle, that enabled him to survive.

Further convincing proof was added a few weeks later when two other Navy divers, Chief Torpedomen E. Kalinoski



Left: Navy diving bell, a large inverted tub used for testing submarine escape devices. When submerged, the divers stand with their heads in air space inside the tub. Donning their "lungs," they escape to the surface.

Below: Navy diving experts completing a test. Torpedoman Radie, in the water, has just come to the surface after an escape with the "lung," and is being brought to the boat by Chief Gunner Tibbals.

and P. J. Hoy, using "lungs" of the same type, established a new world's diving record in the same tank by withstanding water pressures corresponding to an ocean depth of 333 feet. The previous record was 306 feet, attained off Honolulu, Hawaii, in 1915 by three Navy divers in regulation diving suits, while engaged in salvaging the U. S. submarine *F-4*.

AFTER making the new record, Kalinoski and Hoy declared they could have gone the equivalent of 400 feet down without injury.

The "lung," invented by Lieut. Momsen, is regarded by naval officials as the greatest contribution to submarine safety in recent years. It is a direct outgrowth of the *S-4* disaster, off Provincetown, Mass., in December, 1927, when brave men died like trapped rats several hundred feet below the surface. Since that tragedy, the Navy has redoubled efforts to develop means of escape and rescue.

Other safety devices, recently perfected, include a new form of "pad-eye," or giant hook attached to the submarine for raising it to the surface if disabled, a marker buoy, released on a cable from the outside of a sub, new types of water-tight doors, and a new diving bell, built especially for rescue work, which fits securely over a submarine's hatch.

In addition there is a deep-sea diving school at the Washington Navy Yard, which graduated twenty-five sailor-divers in June after a six-month course. These men have been specially trained for outside assistance work in submarine rescues. By 1931 the Navy will have trained seventeen master divers, eighty-two first class divers, and 450 divers of the second class.

A gigantic tank, 100 feet deep, is being constructed at the New London, Conn., submarine base, where every officer and enlisted man on submarine duty will receive thorough training in the use of the "lung." A section of a submarine will be built in the bottom of the tank and the men instructed in escapes from 100-foot depths under conditions similar to those in an underwater accident.

TO FIND out more about the new "lung," I talked with Lieutenant Momsen in his office in the Bureau of Construction and Repair in the Navy department. He had just returned from his 302-foot "dive."

"Swede" Momsen, as his fellow officers call him, is a brave man. After inventing the "lung" he first tried it out himself before permitting others to risk their lives. And all of his tests were not made in the comparative safety of a diving tank. Not long ago he stepped out of the salvaged *S-4*, now in use as an experimental submarine, 200 feet below the surface off Key West, Fla. His "lung" enabled him to move slowly to the surface without the danger of fast decompression and the dreaded "bends."

And to step out in shark-infested waters 200 feet down requires more than ordinary courage!

"I didn't see a fish of any kind—and I was glad of it," Lieut. Momsen commented.

"At 200 feet, it was just like twilight. I could distinguish objects fifteen or twenty feet away but not clearly. One hundred feet up the water was quite clear but you know the eyes do not focus good when they are in direct contact with the water."

"How did you feel under the pressure of the 300-foot depth?" I asked.

"Groggy," Momsen replied. "It was difficult even to think clearly. Everything seemed to be slow motion. I could not move my arms or legs as fast as at the surface. It was hard to remember things. My brain would signal a motion to my arm and it seemed seconds later before the arm would respond. It's a most peculiar sensation."

"ABOUT this 'lung,' where did you get the idea? Is it a new one?" I questioned.

"Submarine men have had the idea for twenty years," Momsen answered. "Various types of 'lungs' have been built from time to time but they never worked. They were too cumbersome and heavy.

"After the *S-4* was lost with all hands, the idea of individual escape equipment came to the front again. I happened to be the line submarine officer on duty in the Bureau of Construction and Repair, and I set out to devise an apparatus free from the faults of previous

(*Continued on page 144*)

Training picked men for submarine rescue work in the deep-sea diving school, Washington Navy Yard. Chief Gunner R. A. Cocchia, in diving suit, is descending into test tank, while other students look on.

"80 Miles *on a* Gallon *by* 1939"

Charles F. Kettering, Famous Auto Engineer, Tells of the Amazing 100-Mile-an-Hour Cars We'll Drive in the Future

By HENRY MORTON ROBINSON

"SUPPOSE I offered you a modern 500-watt Aladdin's lamp, and told you to wish for any improvement you could think of in the automobile of tomorrow. What would you ask for?"

Charles F. Kettering, upon whose vice presidential head the General Motors Corporation has placed a four million dollar insurance policy, shot the question at me with an incisive gesture of his big lean muscled hand. I had come to interview this greatest of automotive engineers in his own bailiwick at General Motors headquarters in New York and here he was blithely interviewing me!

As inventor of the self starter, the Delco ignition and lighting systems, Ethyl gas and as one of the most important contributors to the science of motor car engineering, Charles Kettering was eagerly asking me my opinion of the automobile of the future! His dynamic curiosity revealed the characteristic way in which "Ket" keeps in touch with the practical everyday needs of the man at the wheel. No laboratory isolation for Charley Kettering! He's been shooting tough-minded, practical questions at Mr. Average Owner for twenty-five years and answering those questions with fool-proof, sure fire solutions.

"Well," he demanded, "what are you going to ask for?"

For a moment I hesitated and Kettering smiled at my indecision.

"Ask for something big," he urged. "Don't be satisfied with a minor improvement or a petty adjustment here and there. Now that I've given you the chance, ask for something revolutionary, something epoch-making in automobile construction."

"Why," I ventured, "I thought we had just about reached perfection in motor car design."

CHARLES KETTERING was all over me in a tidal wave of protest. "Perfection? Do you call the lumbering, expensive, fragile machine you are now driving *perfection?* Well, I don't. Not by several thousand miles. Why, the automobile of the future will make the present-day contraption look like a hay wagon. Within ten years we'll have automobiles safely traveling 100 miles an hour, weighing less than a thousand pounds, costing less than a thousand dollars, and covering eighty miles on a gallon of gas. Maybe we won't be using gas at all. There's approximately 130 trillion horsepower waiting to be harnessed in ordinary sunlight every day, not to mention molecular energies that we're just beginning to discover. Yes, sir, I'm speaking conservatively when I say that we've only begun to manufacture automobiles.

"THE automobile of the future," says Mr. Kettering, "will make the present-day contraption look like a hay wagon. Inside of another ten years it'll be a wise man indeed who can tell, blindfolded, whether he's riding in a plane or a car." A wild prophecy? Wait till you have read Mr. Robinson's absorbing interview with this "hard-boiled visionary" who, by applied scientific research, has helped to make your car the marvel of efficiency it is today.

IF THE speaker hadn't been one of the most practical and highest-paid automotive engineers in the world, I might have felt inclined to smile, politely, at his startling prophecies. But one doesn't smile when Kettering makes a statement about the exact science of automobile manufacture which he has done so much to perfect. This lanky, six-foot dynamo, who carries the theory and practice (and balance sheet) of the automotive industry behind his flint-gray, spectacled eyes, has the wildest imagination in the history of gasoline engineering. It is this imagination which has led him to conceive the apparently impossible and then work it out in the realm of reality. For he has a canny bump of practicality which keeps him on the straight and narrow path of what he calls "common-dividend sense." One of his jobs, and he has more jobs than there are hours in a day, is to pass judgment on 350 new inventions every week. In appraising a new brake, bearing, or piston ring, he asks himself a single question—a hard-boiled, practical question.

"Will this device work better, longer, and cheaper than the thing it is designed to replace?"

AND to settle this question he has constructed a thousand-acre proving station near Detroit, where he spends his days trying to break the backbone of every automobile and automobile part produced by or offered to General Motors. Every nut, spring, and cam shaft has to meet the practical road tests that "Ket" has devised for it. If he succeeds in ruining a beautiful theory, he is happy. If he fails to ruin it, he is all the happier. And between these two states of mind, the president of the General Motors Research Corporation manages to round out a fairly happy nineteen-hour day.

Scientist that Charles Kettering is, he "thinks popular." He can take research out of the laboratory and make it work for the layman. "Pure research," he is fond of saying, "is pure bunk. If a man hasn't got a cheek-to-jowl contact with reality, he isn't going to perform any Nobel Prize stunts in the laboratory, no matter what college he's graduated from. There are plenty of people with 'ideas,' but I'm interested in proving that ideas can be applied to everyday, practical uses. The trouble with most inventions is this: they won't work under the strain of everyday usage, which is the same as saying they aren't worth the oil that keeps them lubricated. This applies to 99.5 per-cent of the inventions offered me daily."

THE conversation wore around to the role that research engineers are playing in motor car manufacture.

"Mr. Kettering," I said, "can you tell POPULAR SCIENCE MONTHLY's readers, within the limits of a fifty-word telegram, just what the research engineer of a great motor corporation is expected to do? In other words—what your job is, and how you go about it?"

Without hesitation Charles Kettering delivered a compact and logical statement, an impromptu but all inclusive definition of an automotive engineer's job.

"A research engineer asks himself a difficult *technical* question, dives into his laboratory, and (Continued on page 146)

Drawn Especially for Popular Science Monthly *by S. J. Rosenmeyer*

Charles F. Kettering, a Genius of Motor Cars

President of the General Motors Research Corporation, inventor of the self-starter, Ethyl gas, and the Delco ignition and lighting systems, this "hard-boiled" visionary probably has done as much as any other man to advance the science of motor car engineering, and to meet the needs of the motoring public. He is said to be the most practical and highest paid automotive engineer in the world.

cing Your Car's Family Tree

An old-time joy ride. The late Chauncey M. Depew (right), railway executive and United States senator, riding to his office in one of the "benzene buggies" of nearly 30 years ago.

THIRTY years ago there were 700 automobiles in the United States. Today there are about twenty-five million. The first steam-propelled wagon, pictured on this page, traveled two miles an hour. Today Maj. H. O. D. Segrave has driven a car nearly four miles a minute!

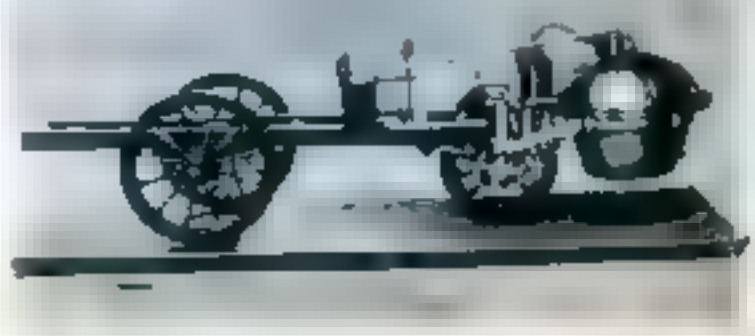
Back of the wonderfully efficient machine you drive is a strange and fascinating ancestry, the story of which is told here in photographs of early days of motoring.

One of the first "roadsters." Thomas A. Edison at the "stick" of a strange electric tricycle car built in the late eighties and largely made possible by his development of the storage battery.

Henry Ford driving his first horseless carriage which he manufactured in 1893. That machine was the grandaddy of more than 16,000,000 autos which the genius of mass production has turned out in thirty-six years.

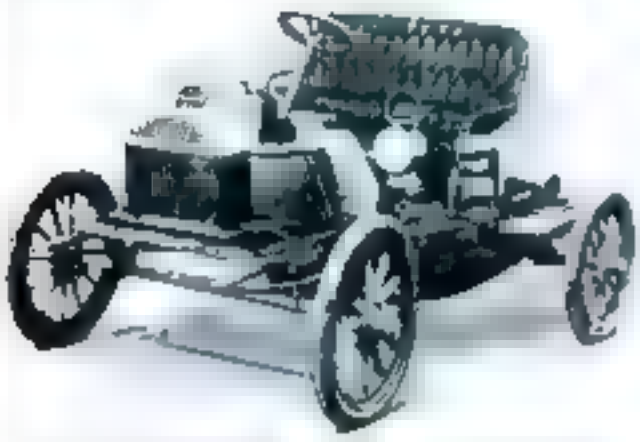
Elwood Haynes, one of the real pioneers of motordom, in his first car. On its maiden trip at Kokomo, Ind., July 4, 1894, it amazed the natives by speeding seven miles an hour. It was one of the first automobiles in America.

Gottlieb Daimler usually credited with the invention of the internal combustion gasoline motor in 1883. But the machine below, built by Siegfried Marcus ten years earlier, is claimed to be the first car propelled by gasoline.

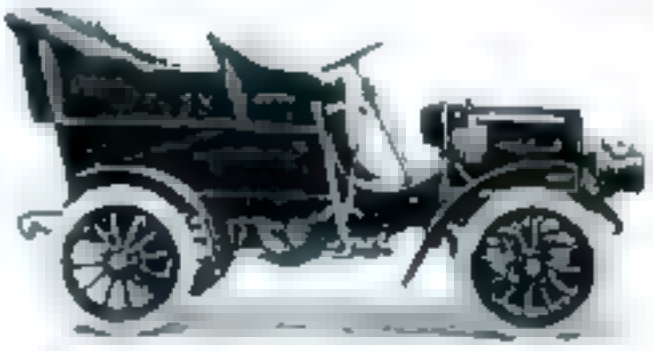


A night Cugnot's crude steam-driven carriage, which was said to scare Napoleon Bonaparte. Built in 1769, it is said to have been the first self-propelled road vehicle.

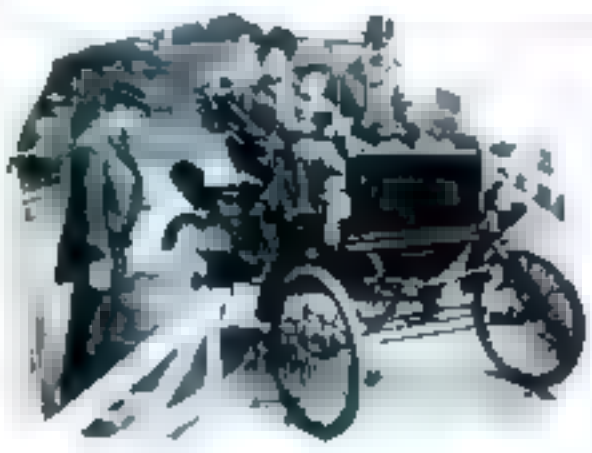
Above is the Cadillac of twenty-five years ago, driven by a one-cylinder nine-horsepower engine under the body. Note the starting crank at the side. At left, Maj. Segrave, world's fastest auto driver with $4,000 1929 Cadillac phaeton driven by an eight-cylinder 90-horsepower motor



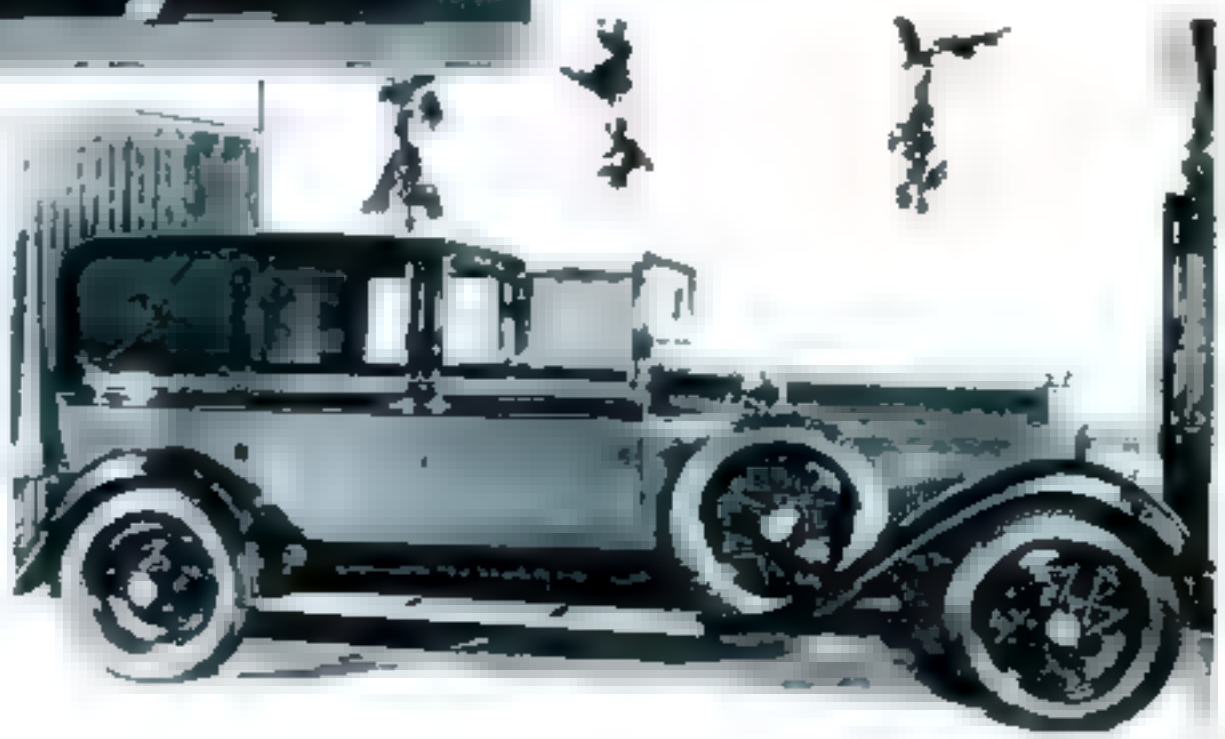
Here is the original forefather of all Buicks as it appeared in 1904—a buggy for two with a two-cylinder 22-horsepower engine under the body. Compare with the sumptuous 1929 Buick sedan at right with its 90-horsepower six-cylinder motor



A quarter of a century of Studebaker evolution has changed this two-cylinder fifteen-horsepower chugger into the luxurious seven-passenger sedan at the left. The power plant now has eight cylinders in line, developing 113 horsepower

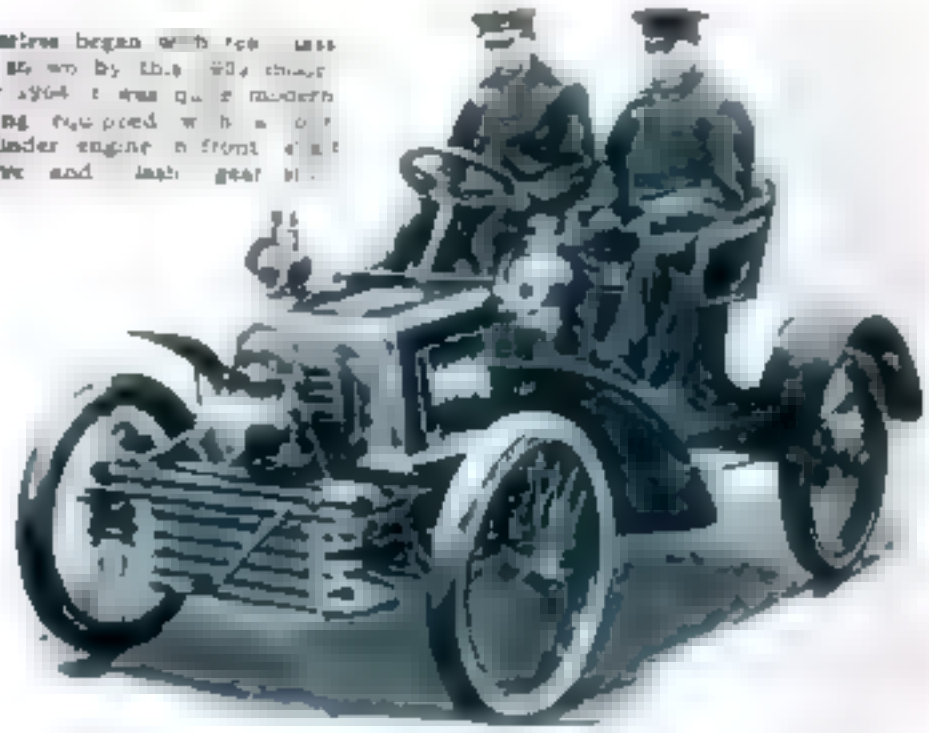


The steam Locomobile of 1900 "doing its stuff" around the arena at the first automobile show in the old Madison Square Garden, New York. You could just about put this old-timer inside of the 1929 Locomobile cabriolet, at the right. From steam to gasoline, and from a rough riding buggy to a smooth running motor car of costly splendor

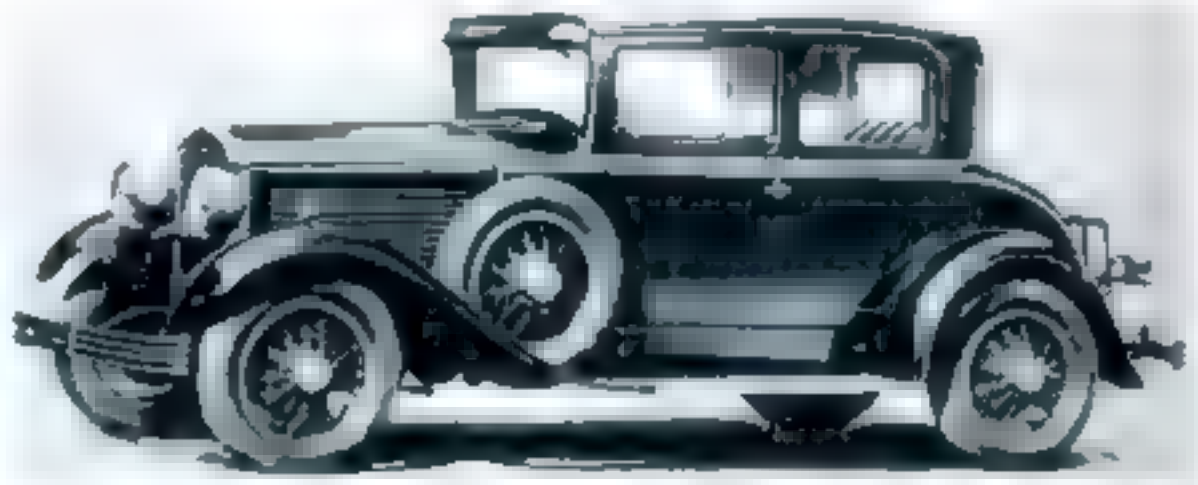


You Don't Have to Be Very Old to Remember the Days When People Poked Their Heads Out of Windows to Watch a "Horseless Carriage"

When the royal coach became motorized King George of England out for the first ride in his new Rolls-Royce, back in the early 1900's. At the wheel is the Rt. Hon. C. S. Rolls later killed in an airplane accident who with F. Henry Royce produced the car whose name has become a symbol of automobile excellency. King George is seated at his left.



Peerless began with ... as ... by this ... By ... it was ... being ... cylinder engine ... drive and ... gear ...



The 1929 Peerless, victoria model. Its engine is still in front, but has grown from four to six cylinders, and from 24 to 81 horsepower. And there's a lot less "clash" to the modern single plate clutch with cushioned driving plate. Comparison with the old-timer pictured above, which was considered the height of luxury in its day, gives a vivid idea of the marvelous advances made in motor car design in the last twenty-seven years. And yet the price of this latest model—$1,345—is only a little more than a third of the cost of its illustrious ancestor.

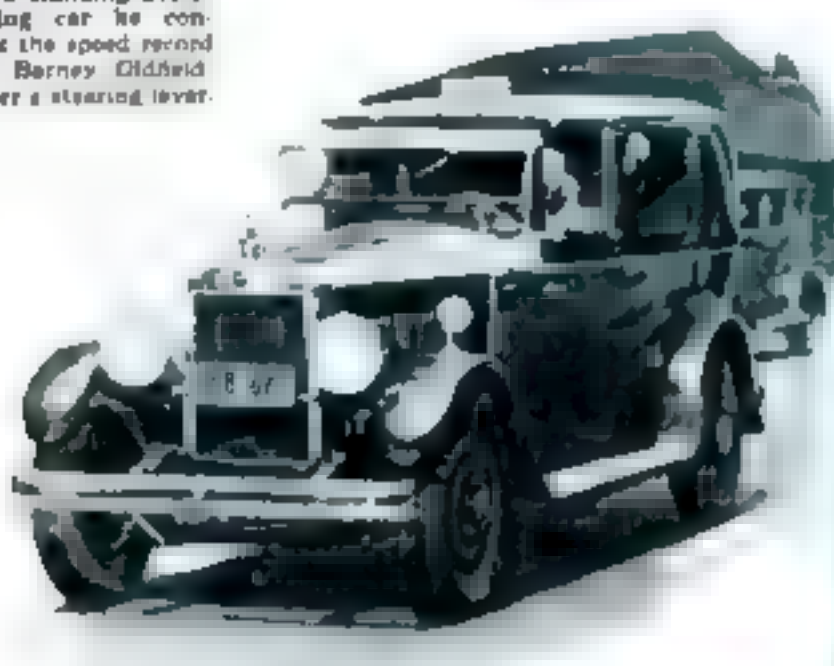
There probably are as many autos as horses on the range today, but when this little Oldsmobile was new an automobile was a curiosity—and a most unreliable one. This rancher has had to enlist the help of a pair of cow-punchers to tow him home by means of their lariats.

The first Marmon—and, at left, one of its 1929 offspring. As early as 1904 it had such new features as pressed steel frame, shaft drive, and three-point suspension. It was the first car with force-feed oiling. The twenty-four-horsepower engine originally was air-cooled, with cylinders in pairs set in a V. With lamps and horn, but without top, this first of the family cost $2,500. There are eight cylinders now, all in line and developing eighty-six horsepower. A lot of improvements in lubrication, too, since that first force-feed system. The new five-passenger sedan, pictured here, costs $2,280, top and all.

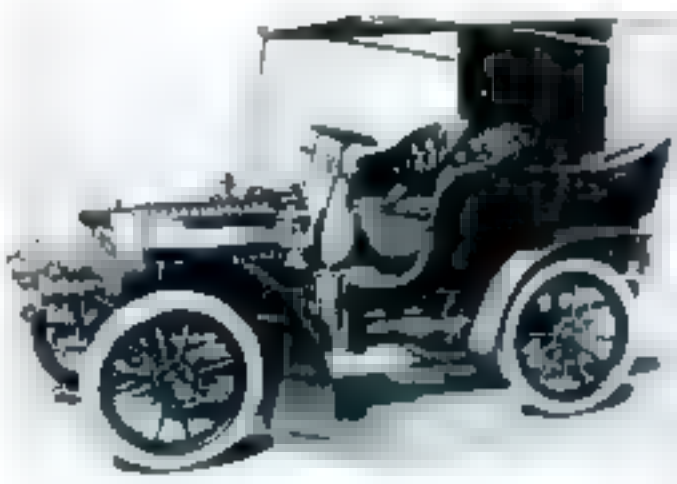
What a Thrill It Was, Then, to Go for a Ride! The Wonder of Automobile Progress Is That the Thrill Seems to Grow Each Year

A great racing team of the early days—Henry Ford standing beside the famous racing car he constructed to attack the speed record for a mile, and Barney Oldfield seated at the racer's steering lever.

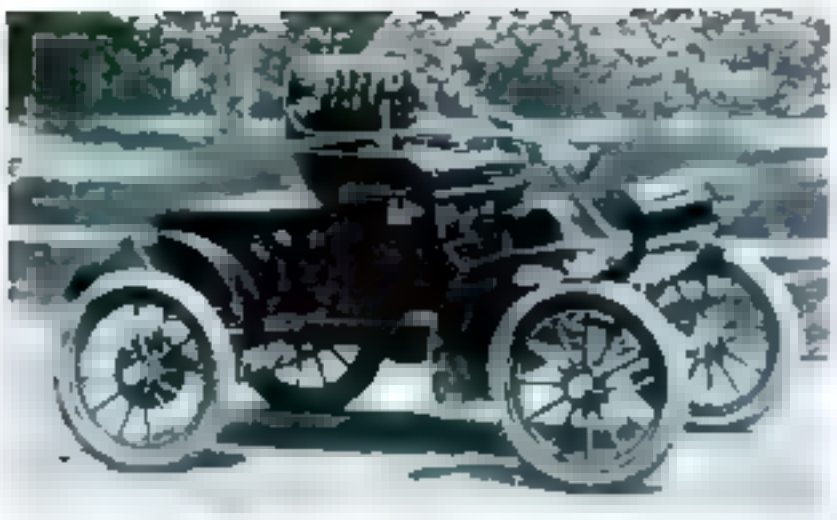
Standing room only—a fully loaded joyride of twenty-five years ago. Those were the days before smoothly paved highways, when the motoring styles called for veils and leather coats as protection from the dust of dirt and macadam roads. Are you old enough to name this car?



The first taxicabs in New York City were electric horseless, like the one in the photograph at the right. They appeared on the streets in 1900. Above is one of their luxurious, high powered descendants which roam city streets by the thousands, devour gas by the tank load and await our call day or night.



Plenty of headroom in this Pierce Arrow of a quarter of a century ago. And the room was mighty well needed over the bumps. Who could have dreamed then that 1929 would see the smooth-running straight-eight sedan, at right, or that Pierce Arrows would be available in thirteen body styles and eight color combinations? Or ever could travel ninety miles an hour?



The car y Oldsmobile More of these cars were sold in 1904 than any other make Its single yl nder engine developed seven horsepower The wheelbase was only 66 n hes and the weight 1 100 pounds The start ng crank was sit below the driver s seat W thout equ pment as pi e was $650

Out of the little one-cylinder runabout pictured at the left grew this smart Oldsmobile roadster of 1929, with a six-cylinder engine developing 62 horsepower, and a wheelbase of 113½ inches. It will carry four passengers, two in front and two in the rumble seat.

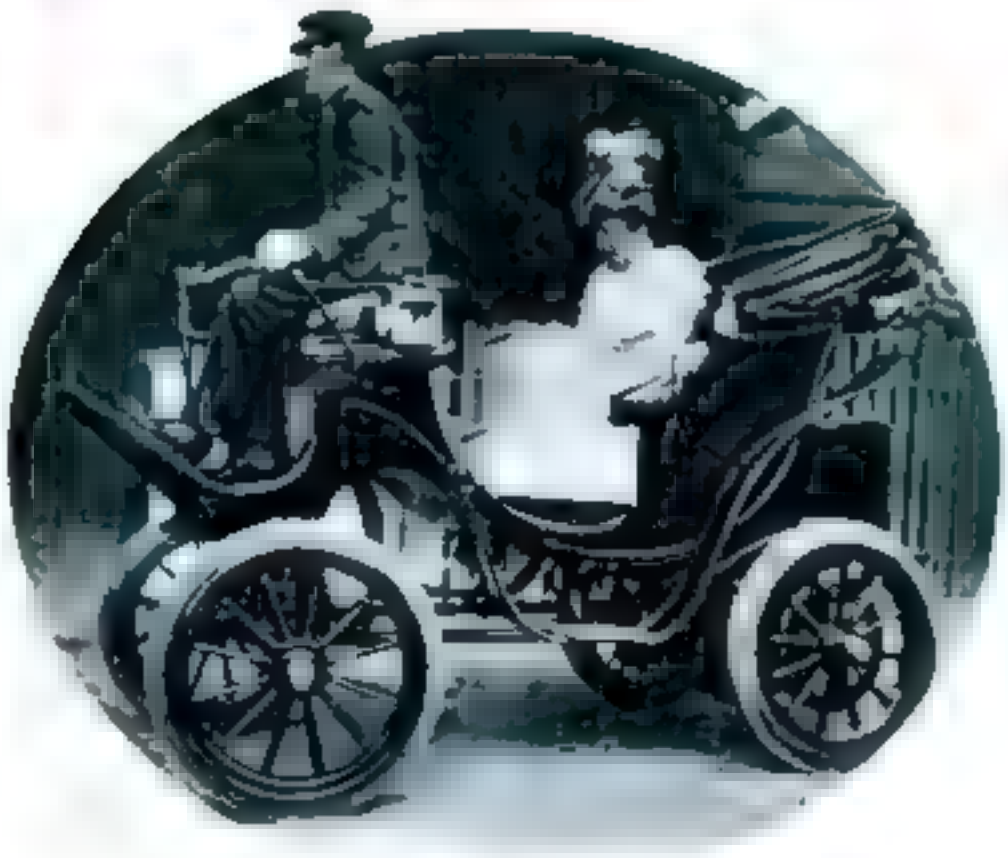
Except in the large cities and their suburbs, this was almost a typical road of no longer than twenty years ago. Little wonder that automobilists were afflicted with tire trouble, and always faced uncertainty when on a trip. Breakdowns were commonplace. Then motoring was a rough-riding sport, and a thrilling adventure, too.

Speeding over the fine highways of today, few people appreciate the hazardous undertaking that even a short motor trip along country roads was until comparatively recent years. On a West Virginia road this tourist had to summon a gang of men with planks and shovels to get him out of the mire. Yes, and the wheels had chains on them, too.

Even in 1904 the Franklin was air-cooled, with its four-cylinder twelve-horsepower engine set crosswise in front for equal cooling of the cylinders. This roadster had an 82-inch wheelbase and weighed 1 175 pounds. Without equipment it cost $1,500. The Franklin of today, at the right, is the only car with an air-cooled motor It has six cylinders, and each one gets its share of cool air even though they're not ranged across the front.

Then—A Thrilling Sport of Hazards, Jolts, and Pitfalls: Now—An Everyday Necessity, Comfortable and Foolproof

One of the first American cars with the engine in front was the Overland. This is the 1904 model, price $800. It had a single-cylinder, five-horsepower engine. The Overland's descendant is the Whippet. Instead of one cylinder, there's a choice of four or six. At the left is the six-cylinder sedan.



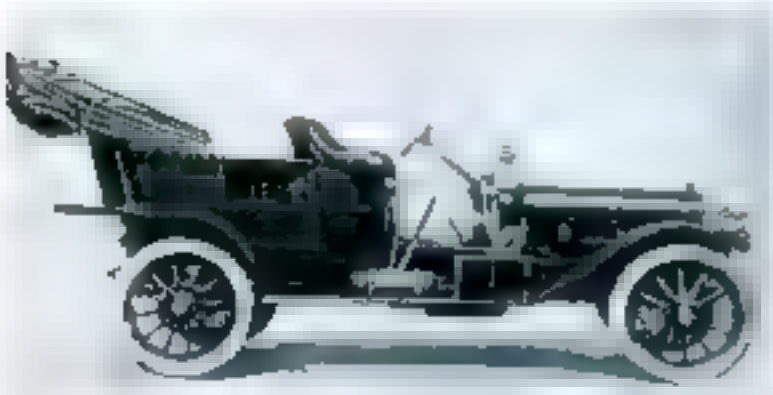
The motorized tallyho—another curious example of the early influence of the horse and carriage. When the first automobiles appeared on the roads, all were designed and built according to the accepted carriage types—buggies, runabouts, surreys, barouches, and so on. Low-slung, streamlined bodies were undreamed of.

When the automobile was really a horseless carriage. An this electric victoria needed were shafts and a horse in place of its storage battery motor and steering lever to join the fashionable afternoon parade of the day. Note the wheel, a ladies' hats

J. Ward Packard at the wheel of one of the first machines which he and his brother created. The Packard was among the few early American cars built along the lines of later years, with a 28-horsepower four cylinder engine in front, drive shaft, sliding gear transmission and pressed steel frame. At right Today's seven passenger Packard eight touring car

Auto Evolution at a Glance—How the Top-Heavy Motorized Carriage Grew into Today's Low-Hung Streamlined Motor Car

ON THE opposite page Roger B. Whitman brings back to memory those dusty, adventurous days of "devil wagons," when to ride was to crank. After you have looked at these pictures, don't fail to read his absorbing story. It will put new luster on your car.



Did you ever see this Ford? It is the Model K of 1905 which could fifty miles an hour. It had a six cylinder 40 horsepower engine, shaft drive and a planetary transmission.

In 1905 this type of turnout was regarded as swell. Here is Mrs. Lenore Carter noted actress, taking an afternoon drive. The high hat for chauffeur was a relic from the horse and carriage days, though an extra chauffeur was handy for emergency

Latest from the Ford factories, the Model A Like its famous predecessor the Model T it is less imposing, perhaps, than the 1905 car but there are more of them

People still talk about this White steamer which was one of the most reliable of all the cars of the early 1900's. With the boiler in front and the engine under the body it made a gentle humming noise as it steamed along. Its chief drawbacks, however, were that it required sometimes half an hour to get up steam for a trip and the high pressure often opened leaks

Streams not are not crossed by highway bridges are rare today. But twenty years or so ago ferry boats like this operated by the river current were common lered by motor tourists in many parts of the country

Alexander Winton, American automobile pioneer at the steering lever of his first experimental model demonstrating it to a crowd of friends. Winton is said to have been the first man to sell an automobile in the United States. That was in 1898

Scorching in My Horseless Carriage

By ROGER B. WHITMAN

AN OLD-TIME auto expert tells here of the one-lung runabouts, hand cranks, and tire pumps of twenty-five years ago.

Back in the early days of motoring Mr. Whitman was technical director of the New York School of Auto Engineering. He was the author of some of the earliest textbooks on the principles of motor cars, and also became an executive of manufacturing concerns engaged in the budding industry.

Even if you were still very young in the days when they shouted: "Get a horse!" you'll enjoy his vivid recollections contrasting the automobiles of then and now. —The Editor.

I WAS almost run over by one of the new Oldsmobiles the other day—a dream of a car, sleek and quiet and the latest word in everything. Being run over by it would have been a distinction. But as I dodged I said, "You needn't get so high-hat with me, you proud beauty; don't try to make me think that you were always as grand as that, for I know better. I knew you when you were a measly little, noisy little two-passenger one-lung runabout with a turned-up nose."

I did too. Many a time have I scorched along in one of those bouncing little contraptions at the breakneck speed of twelve or fifteen miles an hour. And it wasn't so long ago, either—1904. It set me thinking of the days when automobiles were still horseless carriages, and people as timid about riding in them as they are today about traveling in planes.

With automobiles everywhere, and of even greater importance than kitchen stoves, it is hard to believe that such days ever have been, but there on the road is the evidence—cars bearing names that have been honorably known for the entire quarter century. As I reckon it, there are thirteen makes of American pleasure cars so distinguished, and I know of no comparison more startling than of what they are today with what they used to be. They have changed in power, speed, reliability, usefulness, price; and in their development they have overcome the bitter antagonisms that clouded their early years.

To the nondrivers of 1904 a car was a "devil wagon"; its driver was somewhat touched, without regard for the rights of other people, and a dare-devil to "risk his life in one of the things." He scared horses, made an infernal noise, and by the odorous gases emitted by his engine of destruction would undoubtedly kill the vegetation along the highways. Every community expressed its opinion with speed traps.

Perhaps the most consistent offender against early speed regulations was William K. Vanderbilt, Jr., originator of the famous Vanderbilt Cup races. Time and again he was arrested for "scorching" at speeds of fifteen miles an hour or more. Bicycle policemen would tear after his Mercedes and hope that a freight train or some other obstacle would stop the speeding car. Occasionally some stout-hearted constable would step out in front of the on-coming demon and wave a flag that meant "Halt in the name of the law." I remember one time when the famous millionaire was charged with speeding down Broadway, New York, though he protested his car could not do over fifteen miles an hour. Said the judge: "You may not think that fifteen miles an hour is very dangerous, but for the average man eight miles an hour is fast enough." The idea of speed then, of course, was based on the speeds of horses and bicycles.

With dust so thick that in spite of goggles, veils, and dust robes every trip ended in a bath, automobiling in those days was not along any path of roses.

The cars themselves were slim promises of what they might become. Feeble and wabbly, no one knew much why they ran or what was the matter when they wouldn't. A car with a twenty-horsepower engine was in the "big and powerful" class, and one that could run at thirty miles an hour for 100 yards was a racing machine; it was sporting to own one and every drive was an adventure.

The years have brought amazing changes in every detail of mechanism and body. Size, weight, and speed have increased. But in those same years, in an era of general skyrocketing of material and labor costs, the prices of automobiles and of their operation have dropped to an extent that is almost unbelievable. Let anyone who complains of high prices today consider what he would have paid in 1904.

That early Olds is an example, although being in huge production for that day—4,000 were built in 1904—it was distinctly low in price. It weighed 1,100 pounds and its wheelbase was sixty-six inches; it had a one-cylinder engine rated at seven horsepower, and a two-speed planetary transmission. As a sample of the way it was built—and other cars were much the same—its tuner was a nubbin of brass on a shaft that struck a flat spring as it revolved and maybe made contact. I say maybe, for the whole thing was in the open and just where it got the splash from the front wheel. Twenty-five miles an hour was about its limit, and you paid $650 for it with extra charges for a top, lamps, horn, and any other fixings. As for a windshield, such a thing didn't come, the car wasn't even built to take one.

The Cadillac of the same year was more of a car to look at. It was much larger—its wheelbase was all of seventy-six inches—and with a detachable tonneau that you got into from the rear it weighed 1,450 pounds. Without a top it cost $900. The engine was a five by five single-cylinder that developed nine horsepower; it was neatly buried under the body, and the only way to get at it was from underneath. All of the cars with horizontal engines were like that. The body had to come off to get at things from the top, so when they needed fixing you worked from the bottom up and began by crawling under. It was hard luck if the car stopped over a mud puddle; you crawled just the same.

An owner usually took pride in being able to do his own repair jobs. There were no service stations, and you couldn't be sure that the mechanics at the car agencies knew what they were doing, so when things went wrong your best bet was to fix them yourself. That was why you always carried overalls. But when you were hung *(Continued on page 138)*

When Mr. Whitman showed us this photo of himself in his early Toledo steamer, we asked him to tell POPULAR SCIENCE MONTHLY readers what motoring was like in the old days. Here's his story.

Ore carriers steaming through the locks of St. Marys River linking Lakes Huron and Superior. Through this narrow gateway pours the bulk of the nation's iron supply.

"Old Salts" of Fresh Water Seas

Strange Adventures of Great Lakes Skippers Who Brave Freezing Gales, Reefs, and Fogs in Their Ships of Steel

By WEBB WALDRON

"WATCH yourself!"

I had crawled up a greasy ladder from the dock into the hot engine room of the ore carrier *Patrick McCorkell*, then mounted another ladder to the deck and walked forward in the narrow passageway between the aft deck house and the rail.

I jumped back. Above my head dangled a gigantic grab bucket filled to the brim with red iron ore.

I stood there, staring.

I had knocked about on salt water freighters, but this ship, moored alongside a Buffalo steel mill, was something new in my experience of cargo ships. From where I stood, away aft, a tremendous hole stretched to the forward deck house, seemingly three city blocks distant. There was virtually no deck. The top of the ship was all one hatchway, spanned by transverse I-beams. The hatch covers, formed of overlapping steel leaves, were sheathed back toward each rail, leaving only a narrow lane of steel deck on each side.

The ship was, in fact, a long narrow steel ore box slightly pointed at each end, with her pilot house away forward and her engines away aft.

Over her stretched a series of gigantic horizontal steel arms, thrusting out from a towering framework on shore. Along these arms traveled a dozen grab buckets, each controlled by a man high up in a cab. Down dropped the buckets between the I-beams, snatched mouthfuls of ore from the bottom of the ship, shot it up, and dumped it upon the mountain of red ore towering between us and the smelter.

Everything was red—the ship, the boat, the men, the cab. The air was thick with hot, choking, red dust—red, red, red!

Creeping under the sliding buckets, I trudged forward to where the skipper was beckoning from the rail of the forward house.

"Welcome to the ship!" he hailed. He was a solid-built bronzed Norwegian. "We'll get away in half an hour or so."

A man caught hold of my bag and led me into a room alongside the captain's cabin. I have been a guest on salt water freight ships, but I had never been offered such quarters as this. A big room, shiny white woodwork, a bed, not a bunk, a deep leather armchair, an electric fan humming in the corner, a gleaming white private bath. What a contrast to the red clanging turmoil outside!

I glanced around and stepped outside again. Down on the bottom of the hold half-naked men were shoveling the dregs of the cargo into heaps ready for the grab buckets. Aft, the hold was empty.

Moonlight on the St. Marys—a Great Lakes boat passing light marking the channel. On these waters rides a fascinating romance of the inland seas.

THE last dribble of ore was shoveled into the last bucket. The last hatch cover rasped shut. The shovelers scrambled down to the dock. The skipper barked the order to the mate to cast off. "Come on up," the skipper shouted, beckoning me into the pilot house.

The telegraph jingled. The *Patrick McCorkell* quivered, the red mountain of ore and the stacks of the smelter began to move past us. A bridge jackknifed up. We slid through it backward and backed on down the canal into Buffalo Harbor. Slowly two tugs swung our 600-foot length around. We headed out past the south breakwater. On our starboard towered the famous grain elevators of Buffalo.

The skipper glanced at his watch.

"Nine hours and forty minutes since we headed in past that breakwater. Pretty good for 12,500 tons of ore."

We steered out into Lake Erie. Across the west ahead of us flared a salmon-colored sunset.

If the *McCorkell* had

seemed three city blocks long at the dock, now, in open water the unbroken sweep of eighteen hatch covers from forward to aft house looked positively half a mile long.

The skipper grinned at the chart, gave the course to the second mate, then said: "Let's go to chow."

As we walked aft inside the low wire fence which takes the place of a railing on a lake freighter he remarked:

"Last fall up on Lake Superior we fellows up in the mess house got cut off by heavy weather. We couldn't get out to get anything to eat, so cook cut what grub we had aboard. This deck here was one mass of ice a foot thick with seas busting over every other minute. After two days we got desperate hungry. I didn't want to order anybody else to take a chance, so I started out myself. Just as I got about here, a sea caught me and carried me clean across the deck and sat me astraddle of the fence on the other side. I grabbed fast and hung there. It pretty nearly pulled the fingers off my hands. When that sea passed, I crawled back to the pilot house."

"How long before you got anything to eat?"

"About another twenty-four hours," he grinned.

MEN were stretching tarps over the hatch covers and clamping them down with wooden wedges.

"Is all that necessary?" I asked, glancing at the blue mirror of the lake.

"Anything can happen," the skipper replied. "This here is one of the nastiest corners of the lakes. It was right about here I had the biggest scare of my life. I was wheeling in the *Augustus*. The cap's name was Detlifs. We were running for Buffalo with a load of wheat. A southwest snowstorm struck us. Right in the middle of the storm we saw straight ahead a sudden flash of fire through the snow. It was a steamer on fire, flame spouting up through her hatches and her deck houses all ablaze. We could see the fellows at the rail screaming at us to take 'em off. Detlifs stuck his head out of the window and yelled to the mate: 'Tell them fellows to jump aboard when I come alongside!' Then he quickly grabs the wheel away from me and swings us up alongside the other boat.

"Our sides grated together. 'Jump!' the mate yells. Those fellows hesitated a minute, then jumped. A couple of 'em slipped, but they got their hands on our fence and our fellows hauled 'em up. On we went."

The captain and I had reached the mess room in the aft house, where, at the long table, engineers and oilers were devouring beefsteak and beans at a devastating pace. In another smaller room, next to it, firemen and deck hands were doing likewise. We had a cotton tablecloth; they ate from oilcloth. That seemed to be the only difference between the tables.

"But that wasn't all of it," the skipper continued in a moderate tone.

"A FEW miles beyond the burning boat we saw another one anchored, blowing distress signals. She'd anchored to ride out the blow, her anchors had drug, she'd banged her stern aground in shoal water, and knocked a hole in her. She was way down by the stern. We could see her fellows on deck yelling to us to take 'em off. Do you know what that man Detlifs actually did?"

The captain looked at me inquisitively.

"He swung round, headed up into the wind, and let go his anchors. Then he orders the mate to pay out the chain, more and more, letting us back nearer and nearer the other boat. I was scared and I guess everybody else was. If our chains broke or our anchors drug suddenly, we'd smash into the other boat and go down with her. But Detlifs kept yelling: 'Let out some more!' So we drops back and back till our stern touches the bow of the other steamer, and her crew climbed over to us, safe! Then Detlifs rung full ahead, ups his anchors, and heads for Buffalo Light!"

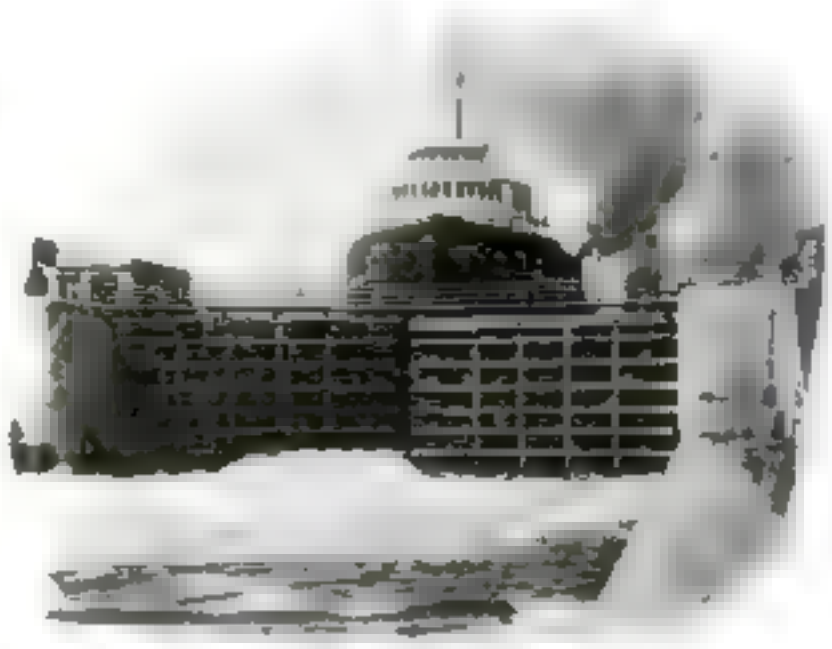
So already I had learned that those salt water men who quite often dismiss the Great Lakes as a string of placid mill ponds have another think coming.

The following afternoon, having run the length of Lake Erie, we were heading northward up the Detroit River toward Lake Huron. The river was wide, but the channel angling among the islands was narrow, and it was exciting to stand beside the skipper and watch him handle the *McCarthy* upstream, noting his quick knowledge of what was not on the chart, which side of the channel to hug to offset cross currents, how fast to put the wheel over at the turns so that our long stern would not strike the side of the dredged channel as we swung. We were one in an almost continuous procession of freighters headed upstream, some loaded with coal, but most of them light, meeting a solid procession of laden carriers

(Continued on page 152)

Weighed with ore after a trip on Lake Superior in December. But look at the freezing gear that are all in the day of the hardy Great Lakes skipper

Left: The steamer *Edward D. Buffalo*, largest boat on the Great Lakes and one of the finest



A freighter in the locks of the "Soo," ready to be lowered. Millions of tons of ore pass through these locks each season.

Learn *to* Fly *with* Larry Brent

"All right, buddy," said Enslow, "take her up. And don't forget where this field is, because I don't want to walk home. Go and do your stuff."

Photographs by D. Warren Hoger

That most delightful employment of my own special and severest critic, pocket watch and empties sooner than a Zeppelin's shed

That First Solo Flight It Brings a Thrill You Never Forget; and a Bigger One When You Try to Land!

By LARRY BRENT

A THRILL that comes once in a lifetime—your first solo! I've done it! It happened at my seventh hour and fortieth minute of instruction. That, I've learned, is a very fair average. Some students solo their fourth or fifth hour, but they are rare. Many students do not solo until their tenth. A few string it out to their fifteenth hour. One of the girl students at Curtiss was not permitted to go up alone until she had had more than twenty hours of dual instruction. But this was not exactly fair. She had a wealthy father who instructed her instructor not to let her solo until he—her dad—gave permission.

Randy Enslow, my instructor, told me about one student he had who did not solo until after his fifteenth hour. That student, Randy told me, was the smartest man on the ground he had ever met—and in the air, the dumbest!

Major J. D. Coth, an R.F.C. ace with twenty-seven German planes to his credit, and now a Curtiss instructor, soloed in one lesson. That was how they taught flyers in the war. You went up for one ride with an instructor. Your one and only lesson lasted for a half hour to an hour. When you came down, the instructor stepped out and "turned you loose." You took her up. Like being booted off a dock, you sank or swam. How those poor fellows cracked them up!

Every time a student, early in his solo stages, cracks up and kills himself, there is a great deal of talk about lengthening the period of dual instruction. Some instructors insist that a student should not be permitted to solo until he has had at least fifteen hours of instruction. Others put the figure higher than that.

The argument other instructors advance against late soloing is this. More than the man who has never flown can possibly realize, a student comes to depend on his instructor to pull him out of difficulties. It is such a comforting feeling to realize that he is in that front cockpit! But it is a bad habit. Particularly in making landings does the average student long to relinquish the controls and let his instructor do it.

THERE are moments, of course, when the most self reliant student must be helped out of trouble. Example: More than once, with every ounce of self-confidence and enthusiasm in the world, I have become "wound up" in tight turns, not remembering in time that in the vertical bank my controls were crossed—that is, the rudder was acting as elevator, and elevators acting as rudder; and on the very verge of a tail spin, my instructor would correct my mistake. Such occasions as these will arise in the course of the most confident student's instruction. But it is assumed that he will not attempt vertical banks or other tricky maneuvers in his first solo.

I TOLD, in a previous article, how my instructor "rawhided" me into developing self-confidence—sitting in his cockpit with his hands behind his head while I overcame ground fright and brought the ship to land. Even if those first few landings were bad ones—and they were—he forced me to rely on myself. And more than anything that an instructor can do, a solo flight will build up a student's self-confidence. Therefore, say some instructors, turn 'em loose early in the game.

Most students do not know when they are to make their first solo. You are seldom told the day before: "Tomorrow I am going to turn you loose. Have a good night's sleep!" Some students might be able to sleep with that on their minds. I know I wouldn't have slept a wink.

But I was certain that the time was coming soon. My take-off was satisfactory to my instructor. My air work was rapidly becoming professional. And my

landings were improving. Sometimes I still tried to stretch out my glide, and sometimes, at the last moment, just before the controls became sloppy in the leveling out, I became a little rattled and either pancaked or bounced—the result, respectively, of leveling off too soon or too late. I had had some tail spins for the sole purpose of learning how to pull a ship out of a spin in case I ever found myself in one.

THEN, just when everything was going smoothly and my day-by-day improvement was perceptible—I went stale. It often happens. It is, in fact, the experience of most students. You progress almost to the point at which you are ready to try out your wings for the first time alone—and one day you seem to have forgotten everything you have learned. You nearly knock the roof off a hangar on your take-off. You cannot come out of a turn without crabbing. And your landings are all but complete washouts. You bounce and you pancake.

My period of staleness began five minutes after Randy Enslow, my instructor, paid me his first real compliment. He said "You're coming along, kid. You re going to make a flyer."

Then we went up for a lesson. Taxiing to the end of the field, I executed one ground loop. Well, a ground loop can happen to the best of flyers—if a puff of wind catches him napping. I headed the ship into the wind, waited for my heat gage to climb up where it belonged, and gave her the gun. I noticed that my head didn't feel clear, and I attributed it to my disgust at the ground loop. Then, as I pulled the stick back to lift the wheels off the ground, the ship didn't seem to respond properly. I thought for a minute that I didn't have enough flying speed.

I PUT the nose down a little, glanced at my tachometer — it registered 1,450 revs, plenty! —then pulled the stick back for a zoom over the hangars. Instead of clearing the hangars by the expected forty feet, I cleared them by about four.

Randy looked back at me. It wasn t exactly bad flying. If I had done it deliberately, it would have been reckless flying. And Randy holds no brief against reckless flying.

I made the turn above the hangars, pulled the stick back

There was Randy, standing all alone on the practice field, looking up at me.

again, and climbed. At about 400 feet I straightened out and decided to try a few figure eights. The ship didn't feel right. Something, somewhere, was wrong.

My first turn was all right except that I did not roll smoothly out of it. I came out of it with a jerk and we went crabbing across the sky. Again my instructor turned and looked at me. His gray eyes in the goggles were cold and inquiring. He jabbed his finger down toward the practice field and I swung the ship around toward it. He wanted me to try a landing. I tried it. When I cut the gun for the glide, I knew something was wrong, but I couldn't figure out what it was. The whistling in the wires sounded wrong. I tried a steeper glide, then a thinner glide. Still the whistling sounded wrong. I could not find the right note.

WHEN I began leveling off, everything was still wrong. I made a pancake landing. Crash! We rolled along and stopped. Randy turned around and asked "What s the matter with you?"

I told him I didn't know.

"Did you snap out of that turn on purpose"

"No. I tried to roll out."

"Did you crab on purpose?"

"No. I was trying to fly straight."

"You're stale." was the verdict. "I'm going to keep you out of the air for a few days."

I felt humiliated, until I

I wasn't mainly thrilled at being up there alone, I was exalted. I felt like yelling and singing. The first few minutes of that solo flight were worth all the sacrifices and hard work in learning to be a flyer.

learned that it happened even to veterans. Some days you will fly better than other days. Some days, Randy once told me, he could not seem to teach anything. Staleness, I learned, may be caused by not enough sleep, too much nervous tension, stomach out of order, dissipation—or it may simply happen, just as the same sort of thing happens to a golfer or a tennis player. Some day, suddenly, without apparent cause, you are off your form, you can't make a good landing to save your neck. Because staleness may be caused by too much flying, most of the transport companies limit the monthly flying time of their pilots to from fifty to sixty hours.

RANDY kept me out of the air for three days. On the fourth, my staleness was gone. My take-off was all right. My air work was as good as ever—I rolled smoothly into and out of several turns, loose ones and tight ones. And I made a half dozen passable landings in the practice field. I knew that it was only a question of a little time before Randy would turn me loose.

But it didn t happen that day. Or the next. But the morning after my return to the air after my staleness, Randy said casually, when I met him at the "lighthouse" for my lesson: "I'd like to have somebody else go along with you today."

ASSEN JORDANOFF, my first instructor, was standing near by and Randy asked him if he would go up and see how he thought I was coming along. Jordanoff was free for the moment and willing. I knew what this meant. Randy had enough confidence in me to turn me loose, but he wanted another instructor to take me for a check flight.

So I went up with Jordanoff and, as on the previous day, my take-off, air work, and landings were satisfactory. Jordanoff's hearty handshake after the flight seemed to indicate that he had no fault to find with me. After the check flight, I asked

Randy strolled back [illegible] the tail and tied his scarf [illegible] That scarf meant: Beware! A rookie is at the controls! Give him room

that when he would solo me. The question seemed to irritate him. He answered:

"Maybe next week, if you don't go stale again. We'll see."

Would it be tomorrow? I looked at the sky clear as a bell. Wind a zephyr. I spent the rest of the day asking students and pilots about their solos, getting advice. Chief Beaver, the school manager, gave me a little lecture on soloing. And Fred Becker, until recently a Curtiss instructor, told me what to do in case things went wrong in the air.

FRED BECKER—Captain Frederick H. Becker—once had one of the narrowest squeaks I've ever heard of. He was testing a cabin plane which had dual controls. These controls were in the front seat side by side. Becker balanced the plane by placing a sandbag in the right-hand seat. He took the precaution of removing the clevis pin and taking out the stick on that side. This left nothing but the socket which came up above the floor about six inches.

Becker took off and started to climb. At an altitude of fifty feet, the sandbag slipped down and jammed in between the seat and the control stick socket.

Down went the nose and down went the ship in a power dive. Becker cut the gun and kicked the rudder, so that when the ship crashed it was swinging around. It was a bad smash. Becker was thrown clear—and spent months in the hospital.

I asked him why he had kicked the rudder.

"When you know you are going to smash up," he answered, "it is a good rule to have your ship revolving when you hit the ground. Bring it in as smoothly as possible, but have it revolving. If it's a cabin plane, the smash will generally break up the cabin and throw you clear of the wreckage. If it's an open plane, you will be thrown out of the cockpit and away from the wreckage. In case of fire, you have a better chance."

I WILL admit that cakes of ice were crawling up and down my spine. I had convinced myself that flying wasn't dangerous—that forethought and good judgment would pull me through anything. But once in a while I wondered.

Becker's worst scare was having his ship catch fire at 14,000 feet. He came side-slipping down, thereby keeping the flames out of his face. He scorched his hands but was otherwise unhurt.

Jordanoff told me of a similar experience. It was in the war. At 15,000 feet his engine burst into flames. Jordanoff cut the gun, then turned the gas completely off, and went down in a vertical dive. A few thousand feet above the earth, the fire burned itself out. He experimentally turned on the gas again. The fire was out and it stayed out. He flew to his airdrome, none the worse for his flaming adventure. Fires are rare occurrences nowadays. Modern engines are designed to prevent them.

Assen Jordanoff (right), my old instructor, shook hands with me after the short flight. He seemed to have no fault to find with me.

I ASKED Jordanoff about soloing. He asked when he was fifteen and had forgotten all the sensations but the tension of cutting the gun for the glide in his first solo landing. That moment, he said, almost turned his hair white.

I slept badly that night. Before turning in, I spent at least two hours on the edge of my bed using the old broomstick handle for an imaginary control stick.

Next morning, just before we took off from Curtiss Field, I asked Randy if today was the day. He answered: "Don't be so impatient."

But I'd like to know.

Throttle down, kid, throttle down. When you're good enough to solo, I'll solo you. Let me see you make some landings that won't dislocate my jaw."

I took off, made a few turns over the field, straightened out, and flew to the practice field. At 500 feet I cut the motor and started to glide. I made a fair landing. He told me to do another. I took off, circled the field, and brought her down again. Pretty good.

"Try another one."

I DID. Another pretty good landing. We rolled to a stop. Then the hair on the back of my neck began doing things. Randy was climbing leisurely out of his cockpit. He was grinning slightly. Not much. Slightly. But I know Randy's grins. This one was bad news. At least, it was at the moment. He glanced carelessly up at the sky. He ran his eyes along the fuselage. Then he strolled back to the tail—and tied his scarf about it.

There was no longer any room for doubt. That scarf on the tail meant: "Beware! A rookie is at the controls! Give him plenty of skyroom, boys!"

Randy strolled back from the tail and looked up at me. It seemed to me he was a little pale.

"All right, buddy," he said. "Take her up. And don't forget where this field is, because I don't want to walk home. And don't get rattled when you cut your gun. Take it easy. Use your nut. Do your stuff."

It was casual. Altogether too casual. I was about to take my own precious life in my own dumb hands. For the first time I was to take an airplane up alone—and there wouldn't be any Randy there to pull me out of trouble!

BUT I didn't hesitate. I gave her the gun. I looked up and to right and left to make sure that all was clear. The ground was slipping by. The controls lost their sloppiness. That front cockpit—

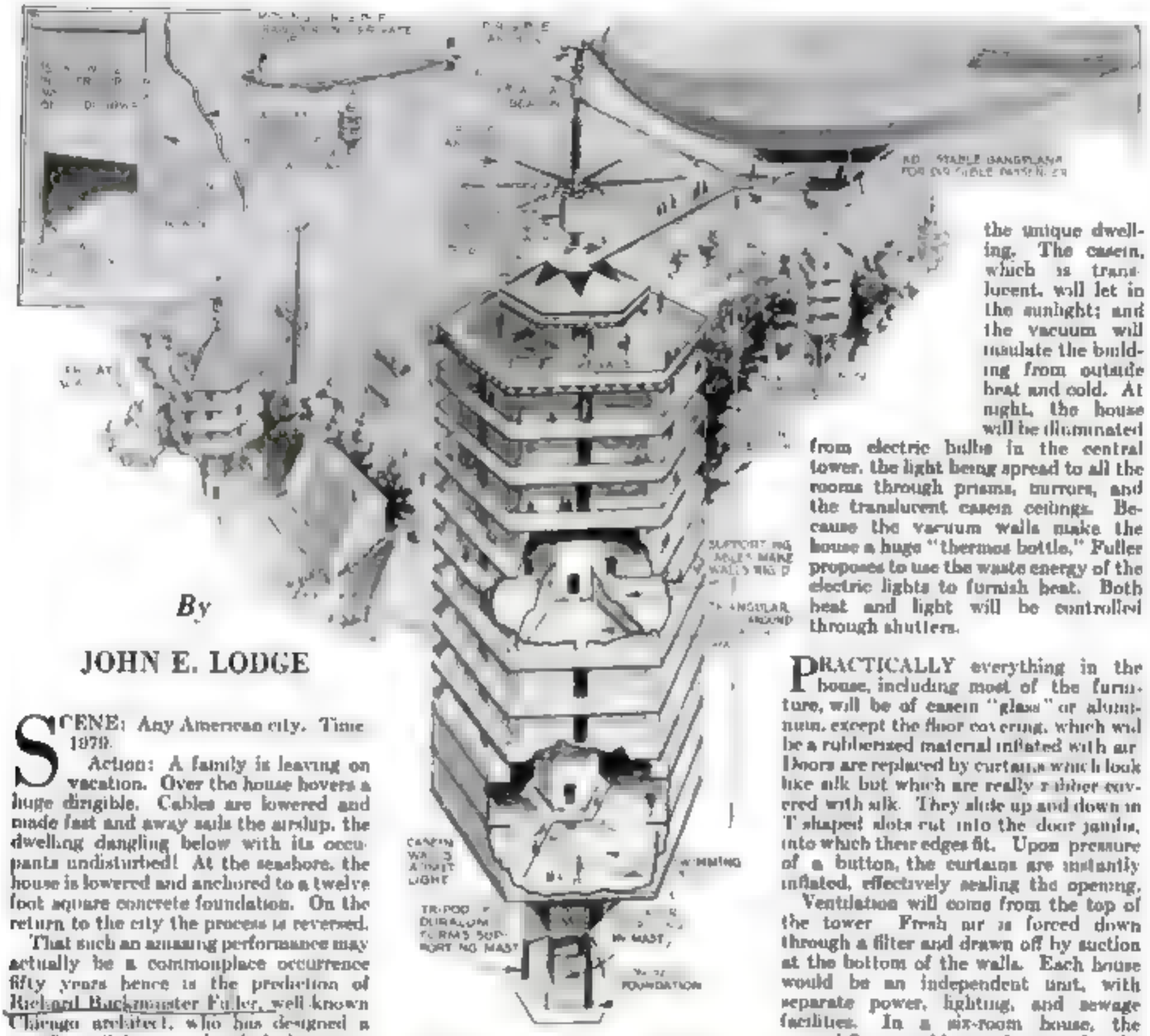
That front cockpit, empty of my best pal and severest critic, would look, other students had told me, as large and as empty as the mouth of a hippopotamus at feeding time. They were wrong. It looked larger and emptier than a Zeppelin's shed.

But I wasn't scared. It almost scared me to realize how unscared I was. I had expected to be terrified. Well, that came a little later. But I wasn't scared on the take-off. I was surprised at the lightness of the ship with Randy out of it. It seemed to me that no pull at all on the stick took her off the ground. I climbed.

I banked and turned. Five hundred feet below and (Continued on page 156)

Gently I pulled the stick back. And gently I set her down on three points! Well, I had soloed. I wasn't a rookie now.

Plans to Move Homes by Airship



By

JOHN E. LODGE

SCENE: Any American city. Time 1979.

Action: A family is leaving on vacation. Over the house hovers a huge dirigible. Cables are lowered and made fast and away sails the airship, the dwelling dangling below with its occupants undisturbed! At the seashore, the house is lowered and anchored to a twelve foot square concrete foundation. On the return to the city the process is reversed.

That such an amazing performance may actually be a commonplace occurrence fifty years hence is the prediction of Richard Buckminster Fuller, well-known Chicago architect, who has designed a startling "thermos bottle" home in which the floors branch from a central mast like the limbs of a tree.

The structure is hexagonal in shape, like the pagodas of the Orient. The central tower, or mast, is formed by a tripod of duralumin tubes set firmly in a concrete foundation. The floors are suspended from this mast by wire cables similar to those used in airplanes. These cables run through the walls, making them rigid.

BUT what would happen if a strong wind struck such a house? The architect replies that tests have convinced him that such a structure, rooted in concrete, could withstand any wind up to 1,000 miles an hour.

Two thin sheets of casein, the material used in molding fountain pen barrels, with a vacuum between, are to form the walls of the unique dwelling. The casein, which is translucent, will let in the sunlight; and the vacuum will insulate the building from outside heat and cold. At night, the house will be illuminated from electric bulbs in the central tower, the light being spread to all the rooms through prisms, mirrors, and the translucent casein ceilings. Because the vacuum walls make the house a huge "thermos bottle," Fuller proposes to use the waste energy of the electric lights to furnish heat. Both heat and light will be controlled through shutters.

Plan of "thermos bottle" house with moored airship. Inset upper left: draft proof door

R. B. Fuller, Chicago architect, and model of tower house he says can be produced for $3,000 and erected in one day. Rooms are triangular, and their casein walls admit sunlight

PRACTICALLY everything in the house, including most of the furniture, will be of casein "glass" or aluminum, except the floor covering, which will be a rubberized material inflated with air. Doors are replaced by curtains which look like silk but which are really rubber covered with silk. They slide up and down in T shaped slots cut into the door jambs, into which their edges fit. Upon pressure of a button, the curtains are instantly inflated, effectively sealing the opening.

Ventilation will come from the top of the tower. Fresh air is forced down through a filter and drawn off by suction at the bottom of the walls. Each house would be an independent unit, with separate power, lighting, and sewage facilities. In a six-room house, the ground floor would provide space for the family automobile and airplane. On the second floor would be the living quarters, reached by a small elevator running through the central tower. The top floor would serve as a roof garden.

In mass production, Fuller estimates that such homes could be produced with all modern conveniences, such as pneumatic beds and sofas, electric stove, dish washer, and clothes washer; built-in radio, etc., to sell for as little as $3,000. Moreover, the house might be delivered and "planted" in a single day.

Larger structures—twelve-deck apartment houses, tall office buildings, tower garages—can be built on the same plan, Fuller declares. Such an apartment building, with swimming pool, sky promenade, and dirigible landing platform, is portrayed here by our artist.

Back of the Month's News

Our artist's portrayal of the new Japanese airplane carriers *Kaga* and *Akagi* in action. Strange down turning funnels divert smoke and fumes from the landing decks. A naval plane is seen laying down a phosphorus smoke screen behind the vessels.

By KARL VOOGHT

TWO strange warships, with huge funnels curling down toward the water like elephant's trunks, recently joined the Japanese Navy. They are the latest airplane carriers, the *Kaga* and the *Akagi*. With them the problem of keeping smoke and fumes from the engines away from the landing platform on the upper deck was solved by using the down-curving "trunks" in place of upright funnels.

On both sides of the *Kaga* these queer funnels extend nearly half the ship's length, turning outward near the stern to belch forth black clouds of smoke that increase the density of smoke screens laid about the war vessel. The *Akagi* differs in that both its funnels are brought out on the starboard side and only one curves outward and downward. The other is upright.

When smoke is pouring from an upright funnel, a plane carrier has to be maneuvered so the wind blows the cloud away from the deck. Otherwise pilots of battle planes have difficulty in seeing to land. The trunked funnel will allow the latest airplane mother ships to steam ahead irrespective of the wind's direction.

The 91,000-horsepower *Kaga* can carry its sixty fighting planes at a speed of more than twenty-five miles an hour. The *Akagi* is slightly longer and narrower. Her upright funnel will be used under ordinary steaming conditions and the "trunk" when airplanes are in flight.

New Sources of Gasoline

CONSTRUCTION was started recently at the refinery of the Standard Oil Company of New Jersey, at Bayway, of a unit to be known as the "hydro-plant" which, when completed, will be devoted to the hydrogenation of petroleum products to produce new supplies of gasoline.

The building of this new unit marks the first step in what experts believe will develop into a revolution of the oil industry. Conservation of enormous quantities of petroleum will be the principal effect of the new process, application of which is said to result in the production of 100 percent of gasoline from every barrel of oil! At present, an average of only forty percent is obtained by the cracking process—the breaking up of crude petroleum into its constituent parts by the application of heat and other methods.

The hydrogenation process, invented by German scientists and developed by American chemical engineers, employs hydrogen under high pressure and a catalyst—a chemical promoting the reaction of other chemicals without being itself affected. Through it, the heavy fuel oil and other residue, known as "ends," left heretofore after refining, can now be converted into gasoline.

BUT this is not the only chemical magic recently devised to solve the problem of an ever-dwindling oil supply and a demand for gasoline that grows by leaps and bounds. For some time synthetic gasoline made from soft coal has been produced profitably in Germany through a process invented by Dr. Friedrich Bergius, of Heidelberg. Briefly, the method consists of breaking up the coal into small grains, mixing it with a small quantity of crude oil or tar and a catalyst in a strong cylinder, and passing over it water gas under a pressure of 3,000 pounds to the square inch and at a temperature of 1,472 degrees F. Last year, 70,000 tons of gasoline were obtained by this process at the Leuna plant of the German Dye Trust, and this year a total production of 250,000 tons is expected.

The substitution of alcohol for gasoline is another suggested means of averting a motor fuel famine. Some experts, how-

How Much Do You Know About Plumbing?

TEST your knowledge with these questions, chosen from hundreds asked by our readers. Answers are on page 142.

1. What is the best way to clean a clogged drainpipe?
2. When you shut off the water why is there a knocking sound in the pipe?
3. What are the relative advantages of steam and hot water heating?
4. Why do they put so many apparently useless kinks in drainpipes?
5. Where can I get a filter that will take all germs out of the water?
6. Should I drain the water out of my hot water heating system in summer?
7. Which is better, an instantaneous gas hot water supply or the storage system?
8. How much more does it cost to pipe a house with brass? Is it worth it?
9. What is the best way to use the heat of the furnace to get a hot water supply?
10. Why is it that every time I light the gas water heater it pops back?

ever, oppose the idea, pointing out that engines start badly on alcohol and that it does not produce as much energy as gasoline. Another objection, that alcohol cannot be produced in sufficiently large quantities, is answered by chemists who have demonstrated that all sorts of waste material, including straw, cornstalks, pea vines, and cotton plant wastes, can be converted into alcohol.

In Scotland, petroleum has been produced for some years from shale. As vast quantities of this stratified rock formation are found in Colorado, Utah and other western states, shale may prove one of America's chief future sources of oil.

Natural petroleum was formed from plant materials buried in rocks for thousands of years and also from the remains of animals, fish, shellfish, and a multitude of microscopic creatures. Both gasoline and kerosene are obtained by heating crude petroleum.

Where the Comets Come From

THAT comets are not members of the original solar family, but children adopted from starry space by the sun at a very advanced age, is the theory recently supported by Dr. N. T. Bobrovnikoff of Lick Observatory. Most astronomers have assumed that comets were born much in the same manner and at the same time as the earth and other planets when, a billion or so years ago, a wandering star nearly collided with and partially disrupted our sun by its tremendous gravitational force. The planets are probably condensed fragments of the catastrophe, while the comets and meteors were supposed to be the lighter portions of the ejected material.

The head of a comet, very likely consists principally of meteors, rock, particles of dust, and large quantities of gas causing its customary hazy appearance when far from the sun. As a comet nears the sun its brightness increases enormously. The output of gas, distilled from the solid matter, is greatly increased by the solar warmth. From time to time explosions occur within the nucleus, jets of gas are shot from the comet's head and go to form the tail. The intense rays of sunlight act on these minute ejected particles much as a high wind on smoke. They stream out in a long train, not in the comet's wake, like exhaust gases from a motor car, but literally blown away from the sun by the force of light pressure. Thus, as a comet swings around the sun, the tail may actually precede the head.

DR. BOBROVNIKOFF finds, from studying the brightness of comets, that they cannot be much more than a million years old. If this be true, how and where did the sun obtain its cometary horde? Dr. Bobrovnikoff points out that a million years ago our solar system was some seventy light-years distant from its present position, in the general direction of Orion, where extended nebulous regions are plainly visible. Some time in the past few million years, the sun passed through this nebulous space and probably captured its comets in transit. Our comets, therefore, may once have formed part of the nebulous Orion regions, the most brilliant part of which is shown in one of the accompanying illustrations.

After all the gases and dust are driven from the head by the action of light pressure at successive returns to the sun, a comet is reduced to little more than a swarm of meteors. The Asteroids, a group

The Kordamia comet, as seen on July 13, 1893. The queer knotted and broken appearance of the tail is due to a [illegible]

The famous Halley's comet, photographed in June, 1910, moving tail first. The latest theory is that a million years ago this and other comets were stolen from far distant space by our sun as it passed through the starry region of the great Orion nebula shown at the left.

of minor planets that lies between the orbits of Mars and Jupiter, Dr. Bobrovnikoff suggests, may be extinct comets rather than fragments of an exploded planet or meteoric material that failed to condense into a planet.

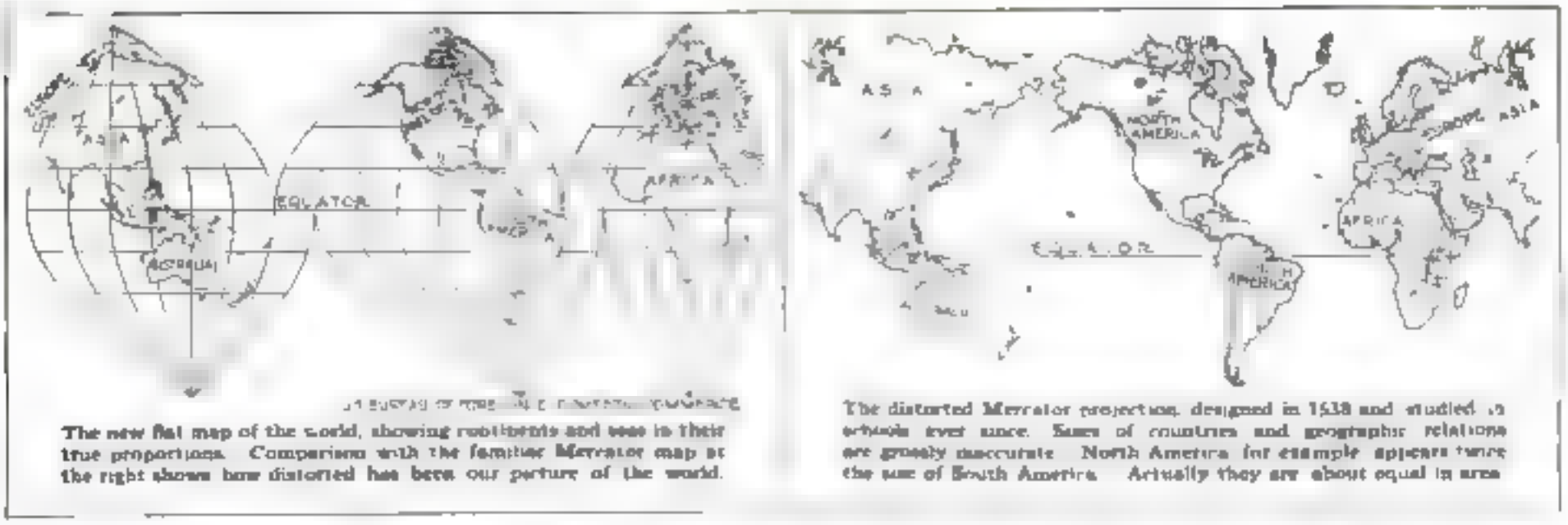
Riding Rainbow Trains

RESPLENDENT in blue and gold, and with all of its working parts finished in glittering chrome nickel like a custom-built automobile, the locomotive of the *Blue Comet*, a new high-speed train running twice daily between New York and Atlantic City, astonished travelers recently when it was put into service by the Central Railroad of New Jersey. The cars themselves resembled rolling boulders in their delicate decorations of cream and azure.

Taking a leaf from the style-book of the automobile industry, the railroads are going in for color in their passenger equipment.

The locomotives that pull the *Wonder Man Express* of the Boston & Maine between Boston, Mass., and Troy, N. Y., are wonders of modernistic design. The passenger engines of the Baltimore and Ohio are far from dull in their Pullman green with plenty of red and gold striping. The fast passenger express of the Chicago Great Western, running daily between Rochester, N. Y., and St. Paul and Minneapolis, Minn., is a dazzling vision of red and gold from stem to stern. The principal trains of the Wabash and the Chicago and Alton between Chicago and St. Louis thunder through way stations like streaks of red-and-brown and blue-and-gold.

Gayly caparisoning the iron horse and robbing the rainbow to brighten up the coaches it pulls in, however, not a new notion. Though the first locomotives of John Stevens, Peter Cooper, William Norris, and Matthias Baldwin were crude and ugly, toward the middle of the nineteenth century the engines became things of beauty as well as of power. The pioneer in the field of designing handsome locomotives was William Mason, of Taunton, Mass. Other locomotive builders followed his example. About 1850 they conceived the idea of adding color. Locomotives glowed in purple, red, yellow, and blue, and the gay surfaces were richly embellished with scrolls and other decorations. Blank spaces were filled in with landscapes, elk and buffalo



The new flat map of the world, showing continents and seas in their true proportions. Comparison with the familiar Mercator map at the right shows how distorted has been our picture of the world.

The distorted Mercator projection, designed in 1538 and studied in schools ever since. Sizes of countries and geographic relations are grossly inaccurate. North America for example appears twice the size of South America. Actually they are about equal in area

heads, and even portraits of politicians!

But some years later there came a reaction to the other extreme—black. Brilliant hues on railroad cars were retained a little longer. The coaches of the New York Central & Hudson River, first a bright yellow, changed to a deep red before they finally adopted the dull Pullman green. For many years, the New York Central and the Lake Shore jointly ran an express from New York to Chicago which was painted a creamy white.

The World Map Corrected

THERE are so few places which have not been explored that we take it for granted that our maps give us an accurate picture of the world, yet nearly everyone has a very distorted idea of the sizes of most countries and their geographical relations to each other. The blame lies in the map of the world which we studied in school and which children still study. This map was originally designed by Gerardus Mercator in 1538 and is known as the Mercator projection, or system of showing the world on a flat surface. It gives us a pretty but grossly inaccurate picture. Alaska, for instance, stands out like a continent, and yet it is only about three fourths as large as that portion of the United States east of the Mississippi. The United States appears twice as large as Brazil, although it is smaller. North America is shown as twice as large as South America, though they are approximately equal in area. Greenland is shown as being larger than Australia, and yet Australia is more than three times as large as Greenland. Quite a difference!

Recently the geographic section of the Bureau of Foreign and Domestic Commerce of the U. S. Department of Commerce completed a correctly proportioned flat map of true areas and distances—the result of five years' work by experts. One look at this new map, reproduced above, reveals how false are our ideas of the sizes of many countries.

The trouble with the Mercator map is that it was designed as a chart for sailors rather than as an accurate picture of the world.

Its principle and the reason why it is so distorted can be explained by a familiar example. If you painted the map of the world on a toy balloon you would have a fairly accurate globe. If you were to slit that balloon from top to bottom on one side, the result would be a flapping piece of rubber. Suppose you stretch that torn balloon until it makes a flat rectangle. It takes a lot of stretching at the top and bottom and almost none at the middle, or equator. The pictures of countries near the two poles have become distorted out of all proportion to their real size, even though the equator line remains the same length as before. Your flat rectangle of rubber would look much like a Mercator projection.

The new map is made somewhat as though you split your balloon from top to bottom but then made two slits up and down into the Pacific and two slits up and down into the Atlantic, afterward spreading it on the table without stretching. Looking at it, you get an idea of a flat surface and you are not deceived as to the size of any territory.

Every square inch on the new map stands for exactly the same number of square miles as any other square inch. Distances along the lines parallel to the equator are accurate and true to scale. So also are distances on each vertical meridian that extends through the center of a continent. There is some slight distortion in distances elsewhere on the map, but it is vastly less than on the Mercator projection. Lines are so adjusted that land areas are especially close to accuracy.

Geographers who have examined the new map have predicted that it will take the place of the old map in all things except for navigation.

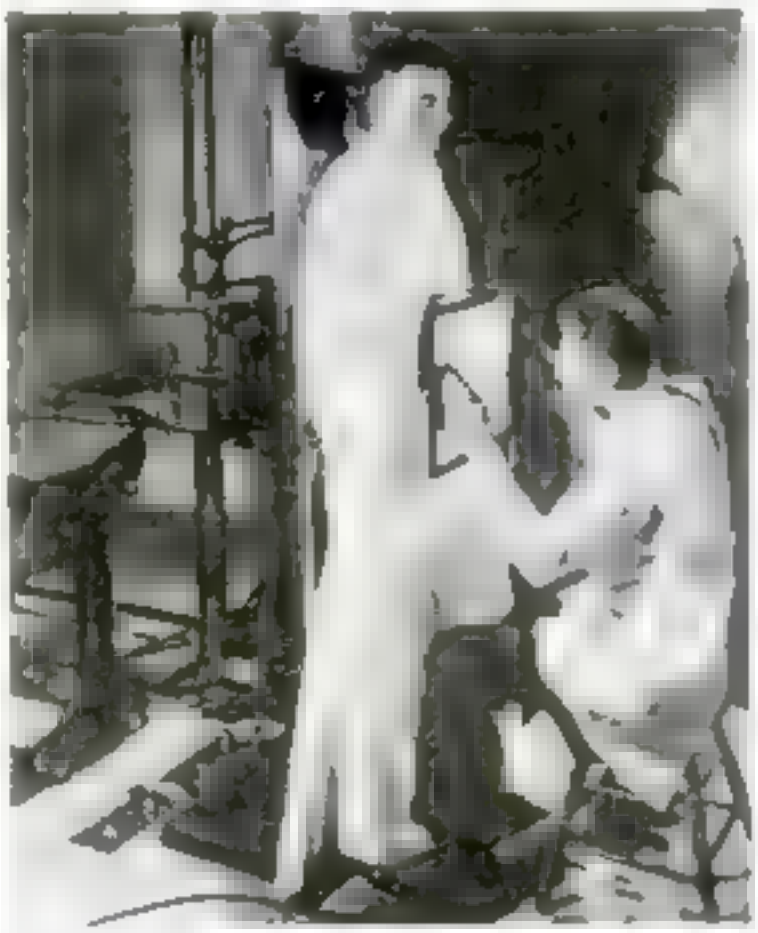
X-Rays Made Shock-Proof

A NEW type of X-ray apparatus, recently installed at the Neurological Institute in New York City, is completely insulated in oil and all overhead high-voltage wires have been eliminated. These improvements are said to make accidental electric shocks to operators or patients impossible.

In the thirty-four years that have elapsed since William Roentgen, German physicist and father of the X-ray, accidentally discovered that these vibrations of the ether could penetrate solid matter, their use in hospitals and clinics has become almost universal. This latest refinement in the apparatus that produces them will further increase their value to suffering humanity.

All ether waves, including X-rays, radio waves, light waves, and heat waves, are alike except for length. Radio waves are the longest known. Then come those producing heat, and in descending order, light waves, the waves of ultra-violet light and those of the X-rays.

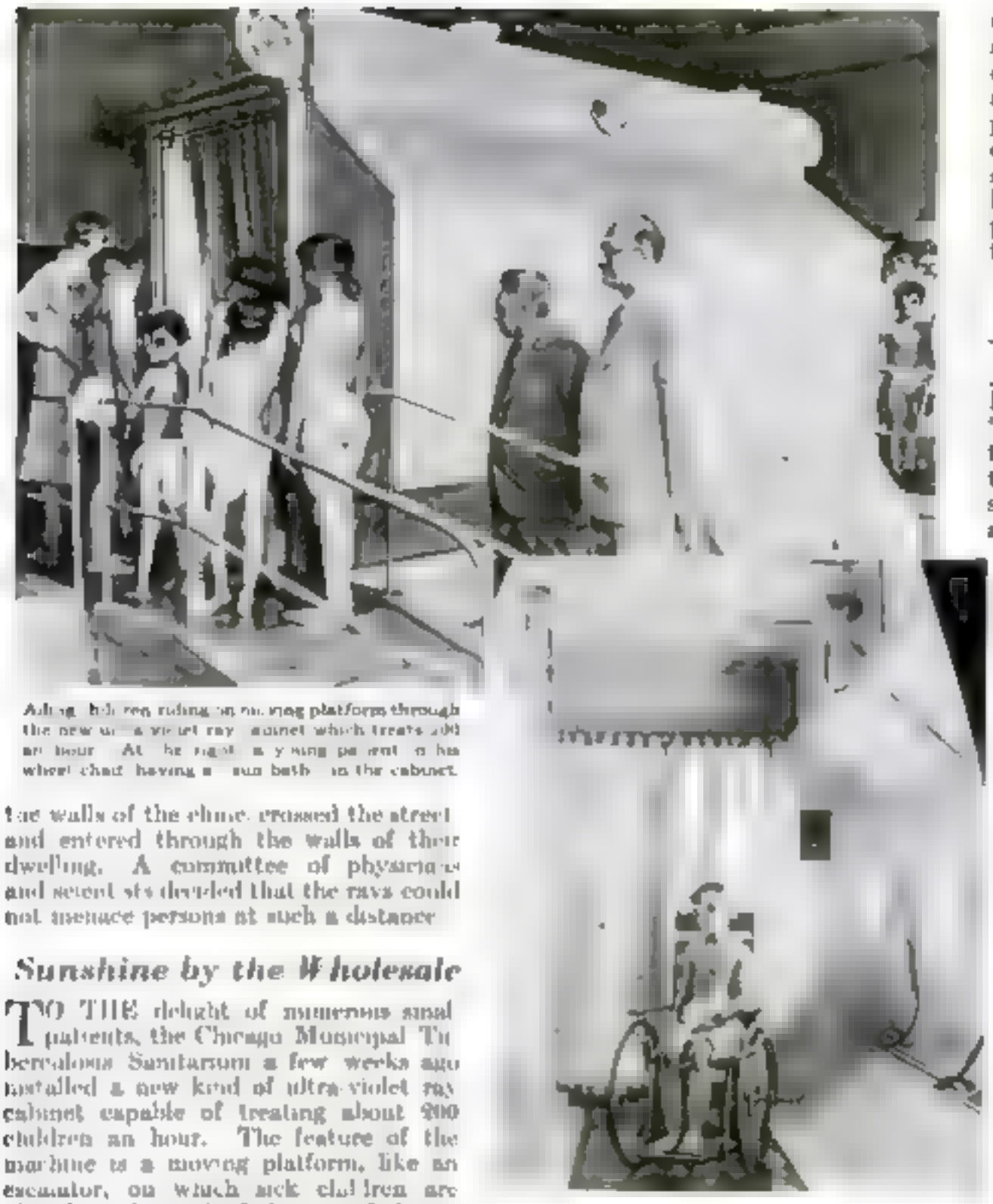
Some X-ray waves are so short it would require more than two trillion to make an inch! Even the longest are so infinitesimal that there are fifteen million to the inch. Other and more powerful rays of recent discovery, such as the Millikan rays and the cathode rays, are shorter even than X-rays.



The newest X-ray apparatus, completely insulated to protect both operator and patient from electric shocks.

AT THE Watertown Arsenal, in Massachusetts, a mighty X-ray machine has been developed which is said to take pictures through four and a half inches of steel.

The question whether X-rays can affect people some distance away was presented in an unusual lawsuit in France, a short time ago. Two people living near a clinic where X-rays were in daily use declared they had contracted cancer from constant irritation caused by the ether vibrations. They claimed that the rays penetrated through the patients, through



Aiding children riding on an moving platform through the new ultra violet ray cabinet which treats 200 an hour. At the right, a young patient in his wheel chair having a "sun bath" in the cabinet.

the walls of the clinic crossed the street and entered through the walls of their dwelling. A committee of physicians and scientists decided that the rays could not menace persons at such a distance

Sunshine by the Wholesale

TO THE delight of numerous small patients, the Chicago Municipal Tuberculosis Sanitarium a few weeks ago installed a new kind of ultra-violet ray cabinet capable of treating about 200 children an hour. The feature of the machine is a moving platform, like an escalator, on which sick children are placed in their wheel-chairs and driven automatically through the narrow space between the cabinet's walls to which the powerful ultra-violet lamps are attached

The new device, the first to make mass treatment with artificial ultra-violet light possible, is the latest indication of the esteem in which "man made sunshine" is held by the medical profession as a curative agent

In 1921, physicians discovered that the ultra-violet rays of the sun were a remedy for rickets in children. Shortly afterward, various types of lamps producing the health-giving rays were developed. Of late, so-called "sunlight lamps" or "health lamps," supplying artificial sunlight, have become popular in the home. The two principal types are the "mercury vapor" lamp and the "carbon arc." The mercury vapor lamp produces energy approximating in quality the invisible ultra-violet rays of sunlight that lie beyond the infra-red, or heat-giving, rays in the spectrum. The carbon arc, on the other hand, produces an imitation of all of the rays of the sun and, according to the U. S. Bureau of Standards, is the closest approach to real sunshine. The mercury vapor lamp is used most in hospitals, while the carbon arc has found much favor for family use.

An ingenious device called a "dosage meter" to determine and control the strength of artificial ultra-violet rays was developed recently by Dr. H. C. Rentschler, of the Westinghouse Lamp Company. The invention operates by means of uranium, the rare element which is sensitive only to the action of ultra-violet light, and a photo-electric cell. It enables physicians for the first time to regulate the intensity of the rays with precision.

After Two Million Years

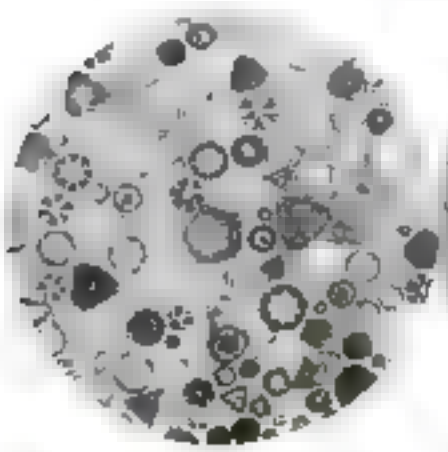
RECENT excavations in Santa Barbara County, Calif., near the town of Lompoc, brought to light a veritable "grab bag" of prehistoric oddities, among them thousands of fossilized fish, such as the flounder shown below; also an extinct species of duck, and parts of a mammoth and of a whale.

The flinty earth in which these fossils are embedded was no less curious. Examined under the microscope, it was found to consist of innumerable skeletons of tiny aquatic organisms called diatoms—millions of them to the square inch. The medley of fantastic shapes, sizes, and designs suggests an assortment of snowflakes and confetti More than 200 varieties have been found at Lompoc, all of them chemically related to the opal, which is a hydrated silica or flint.

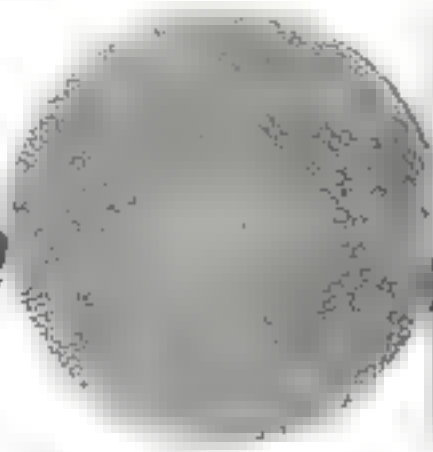
Of more than 10,000 known forms of diatom, there are two general types, those inhabiting shores and shallow bottoms of oceans, lakes, and streams, and those of the free-floating type which move on or near the surface. As the diatoms die they sink to the bottom, and in the course of time large accumulations are built up.

The Lompoc deposit originated from diatoms which lived in the sea. It was laid down during the Miocene Era, about two million years ago. After the deposit was formed, upheavals of the earth's surface raised it above sea level. The total thickness ranges from 800 to 1,400 feet, over an area of 9,000 acres.

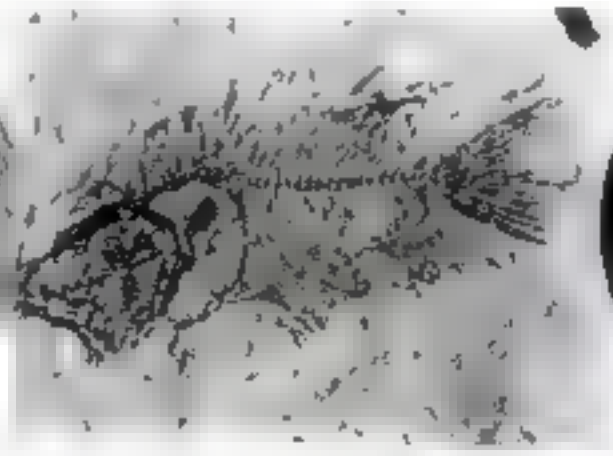
This deposit of silica is used in a number of industries, the material produced from the Lompoc deposit being known commercially as Celite. Because of its porous character, due to its large number of air cells, it is used in powdered form as an aid in the filtration of a variety of food products. Other uses are in the manufacture of heat-insulating materials, and, finely pulverized, as a workability agent in Portland cement concrete, where it insures greater uniformity, strength, and water-tightness.



Highly magnified skeletons of diatoms, microscopic sea creatures. Millions of them can crowd into one square inch.



A diatom of the round or disk type, magnified hundreds of times, showing the many air cells in its structure.



Fossilized skeleton of a flounder found among diatoms in deposit near Lompoc, Calif. Two million years ago this fish swam in a sea which upheavals have changed to dry land.

Three greatly magnified banded diatoms. Deposits of the microscopic skeletons are being used commercially.

Alaska's Flying Gold Hunters

Prospectors Desert Dog Teams for Wings as Planes Chart the Northern Wilds and Open Land of Wealth

By

JAMES M. NELSON

Pilots, photographers, and mechanics of the Alaskan aerial survey with one of the four amphibian planes from which they are mapping thousands of square miles of wilderness in southeastern Alaska

FOR more than two months the ancient quiet of mighty forests in southeastern Alaska has been disturbed by the roar of four amphibian planes systematically criss-crossing thousands of square miles in that district. High above precipitous crags, expert aerial photographers have been recording the secrets of a coastal region so rugged as to make mapping by ground methods almost impossible.

With the airplane tender *Gannet* and a 140-foot barge as a base, the planes have spent weeks taking pictures of little patches of land which, when pieced together by the Geological Survey at Washington, will result in the first really accurate maps of the region.

The expedition, known as the Alaskan Aerial Survey Detachment, is continuing work begun in the summer of 1926, when three Navy planes took some 17,000 photographs of 10,000 square miles of territory. Patching those photos together like a gigantic cut-out puzzle, Government draftsmen constructed a map that has contributed greatly to our knowledge of the "Panhandle," as the region is known. Information obtained at the time also proved of great value to the Forest Service in pointing out distribution and extent of forests and available water power. It is said that the survey of 1926 advanced the wood pulp industry in southeastern Alaska by several years.

For nearly thirty years the Geological Survey has carried on topographic mapping in Alaska, yet in that time less than half its vast area has been covered. The two aerial expeditions have accomplished in half a dozen months what otherwise would have taken many years of laborious effort.

Surveying an extensive area from the air requires a systematic plan for taking the photographs and matching them together into a complete, unbroken photographic map. Elaborate flight charts are prepared in advance showing the parallel lanes to be traversed by the planes.

Flying the plane in which Noel Wien [illegible] is an Alaskan [illegible] Alaska [illegible] Straits [illegible] Asia. The map shows the [illegible] on a long [illegible] [illegible] on the ice off the Siberian coast

Each plane's crew consists of a navigator, pilot, and photographer. The pilot's job is to keep his plane on the designated flight lane, at the proper altitude, and on an even keel. The navigator keeps a constant check on the pilot, signaling directions to him by means of electric lights set in a panel. The camera alone occupies the photographer's attention.

THE present expedition has been photographing the islands of Kuiu, Chiragof, and Baranof, as well as several thousands of square miles on the mainland.

Map making is only one of a dozen services the airplane is performing in Alaska, and all developed since 1920. In the summer of that year Capt. St. Clair Streett led a band of U. S. Army flyers on an epoch-making flight from New York to Nome, Alaska, blazing an air trail over trackless wilderness. Soon afterward business men of Alaska purchased a plane to see if commercial flying would prove practical there. They selected as pilot

Carl Ben Eielson, a young high school science teacher at Fairbanks, Alaska, and former war flyer. It was this same Eielson who piloted Sir George Hubert Wilkins on the first flight across the Arctic ice from Point Barrow, Alaska, to Spitsbergen.

Eielson's pioneer commercial flying was so successful and interest in aviation grew so rapidly that today a network of airways spreads across the country. Fifty-seven airports are maintained in summer, and with skis on planes in winter any smooth stretch of snow or ice becomes a landing field.

NINE planes in Fairbanks maintain regular service to remote points of the territory. One aviation company there is headed by Noel Wien, who not long ago completed a hazardous 2,800-mile flight to Cape North, Siberia, and return, the first round-trip flight between the Western Hemisphere and Asia. Carrying half a ton of food supplies for a fur-trading ship caught in the ice off the coast of Siberia, Wien returned to Fairbanks four days later with $150,000 worth of white fox furs which otherwise would have remained on shipboard until the ice broke up.

So successful was this flight that fur-trading companies are considering further flights to Siberia to bring back sable and squirrel pelts. The Soviet government also is negotiating with Wien to carry provisions to Wrangell Island, where a group of colonists have been isolated for three years. Thirty men and two women were last reported on the island.

Throughout Alaska and Canada prospectors and mining companies have been quick to take to the air. Maintaining base camps in cities or towns, they fly to their diggings, completing in a few hours journeys that would take dog teams several days. The Canadian Department of Civil Aviation estimates that planes flew 834,000 miles over the northland in saving transportation and exploration last year without a casualty. In that same period at least forty-two prospectors, using old-time methods of transportation, lost their lives.

One large Canadian company engaged in aerial explorations for numerous mountains three big camps in the north, each stocked with food for two years, and twenty-six bases where gasoline and oil are cached. Some individual prospectors fly their own planes.

Amphibian planes of the Alaska survey expedition setting out for the North from Seattle, Wash. At left is Joseph Haase, chief photographer of the expedition, with his aerial camera

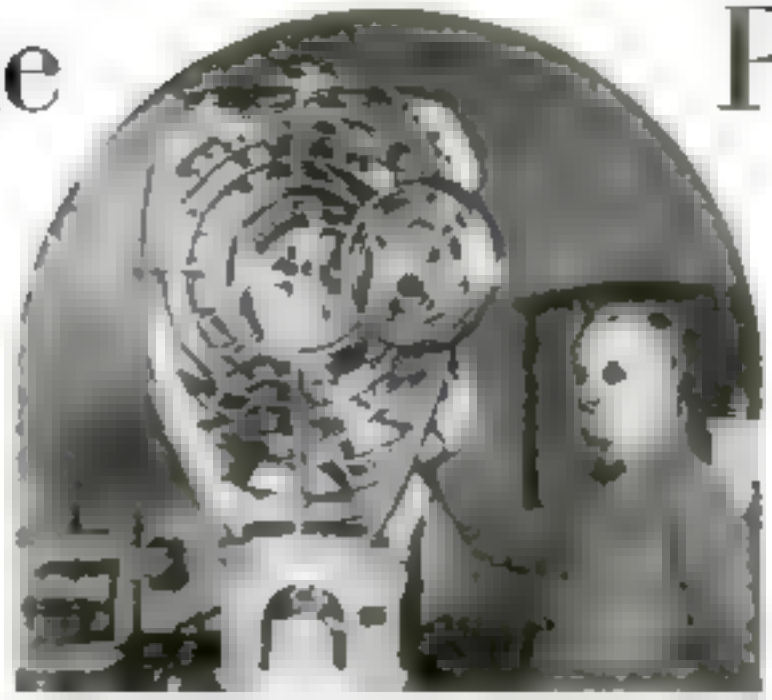
Many free lance flyers carry passengers and freight to all parts of the northland. Some of the sealing ships carry along planes to do their scouting. Until recently a lookout from the masthead was the only means of sighting seals, and whole herds often were overlooked.

One of the greatest services the airplane is performing is that of bringing the outside world to communities hitherto isolated from civilization. Regular arrivals of fresh food and news of the day have given the prospector a new life. The drone of the airplane motor means something far more important, too, because in all interior Alaska there are no physicians except at Fairbanks. From this center planes carry serums and medicine to far-off communities, or return with prospectors requiring hospital attention.

THE airport at Fairbanks is the finest in the territory. It has two runways, each more than 2,000 feet long and 400 feet wide. It is the only illuminated airport in Alaska. The Government recently established a weather bureau in that city, adding greatly to flying safety. Previously pilots had been forced to rely on private advices of Army Signal Corps observers scattered about the territory

Encountering the icy blasts of the North, flying gold hunters build Eskimo snow houses about their airplanes to keep the motors warm. These big monoplanes are engaged in mining exploration.

Men in the Public Eye



Dr Nils Gustav Dalen, Sweden's famous blind inventor and Nobel Prize winner with one of his automatic beacons.

WHEN you travel by train, use the elevated railway in New York, or take a steamer for Europe, your life and limb all along the way are safeguarded by automatic signal lamps and lighthouses designed by a scientist who for almost seventeen years has lived in total darkness. Dr. Nils Gustav Dalen, Sweden's greatest inventor, lost his eyesight in a laboratory explosion in September, 1912. Two months later, he was honored for his contributions to science with the Nobel Prize in physics.

The "Scandinavian Edison" has not permitted his blindness to diminish his usefulness. Day after day, from a brightly lighted office in a suburb of Stockholm, he directs the far-flung activities of the International Gas Accumulator Company, of which he is the head. Besides, he continues his scientific experiments. And though sorely afflicted, this man of almost sixty manages to keep cheerful. His hobbies are the theater, the opera, and his radio.

He started inventing when he was a boy of fourteen, living with his parents on a small farm. Young Nils had to rise early and help in the fields. But he found it difficult to wake up and, in addition, he had somehow developed fondness for a cup of hot coffee in bed! So he rigged up a fantastic contrivance that might well have inspired Rube Goldberg. He repaired a discarded old wall clock and added an alarm mechanism with a piece of tin plate for a bell. Then he combined the clockwork with a little friction wheel covered with emery paper that began to rotate fifteen minutes before the alarm went off. The friction against the rough paper lighted a match. The match was attached to a rod that swung over a gasoline lamp, the cap of which was simultaneously removed by another contraption made from empty wooden spools and string. Over the lamp he had placed an urn containing coffee prepared the night before. Thus, when the alarm awoke him, the room was lighted and the coffee boiling!

August Vollmer police chief and now a University professor.

Thus was Dr. Dalen's first automatic light. Since then, he has perfected many devices, but the Nobel Prize was conferred upon him for his three greatest discoveries, combined in the famous AGA lamp, used chiefly in marine buoys and lighthouses. They consist of a system for storing acetylene gas under high pressure in cylinders, thus making it possible to keep large quantities of gas in small containers safely; a device which, by gas pressure, automatically lights and extinguishes an acetylene gas flame at regular intervals, and finally the celebrated "sun-valve lamp" which is operated by the sun itself. Without human aid, lighthouses and buoys embodying this triple method remain in constant operation for twelve months at a cost of about $14.

The secret of the sun-valve is a bar of platinum painted black to absorb sunlight. The lower end of the bar rests on a lever. As the bar expands under the rays of the sun, it lengthens, pressing down the lever which closes a valve. This shuts off the supply of acetylene gas, extinguishing the light automatically. Conversely, with the approach of evening or dense fog, the bar contracts, gradually opening the vent so that the acetylene gas is free to flow in once more, thus lighting the lantern from a tiny pilot flame burning continuously.

Dr. Dalen, before he lost his sight, visited the United States and saw his lights on the New York elevated and in the lighthouse in Ambrose Channel.

A Musician-Astronomer

TO LOVERS of music the name John Powell long has been familiar. They know him as an eminent concert pianist and as the composer of a *Negro Rhapsody* for piano and orchestra, a violin concerto in E major, the *In Old Virginia* overture, the *Psychological Sonata*, and other works.

But until recently, few except his close friends were aware that Powell was also an amateur astronomer of distinction. The musician had carefully guarded the secret of his hobby.

One day, however, announcement was made in Paris of Powell's election to membership in the Société Astronomique de France, one of the foremost astronomical societies in the world—and the cat was out of the bag. Then it became known that the pianist-composer had devoted his leisure to a study of the stars since boyhood, that he had formulated a new theory concerning the movements of comets, and that he enjoyed the friendship of Camille Flammarion, the famous French scientist.

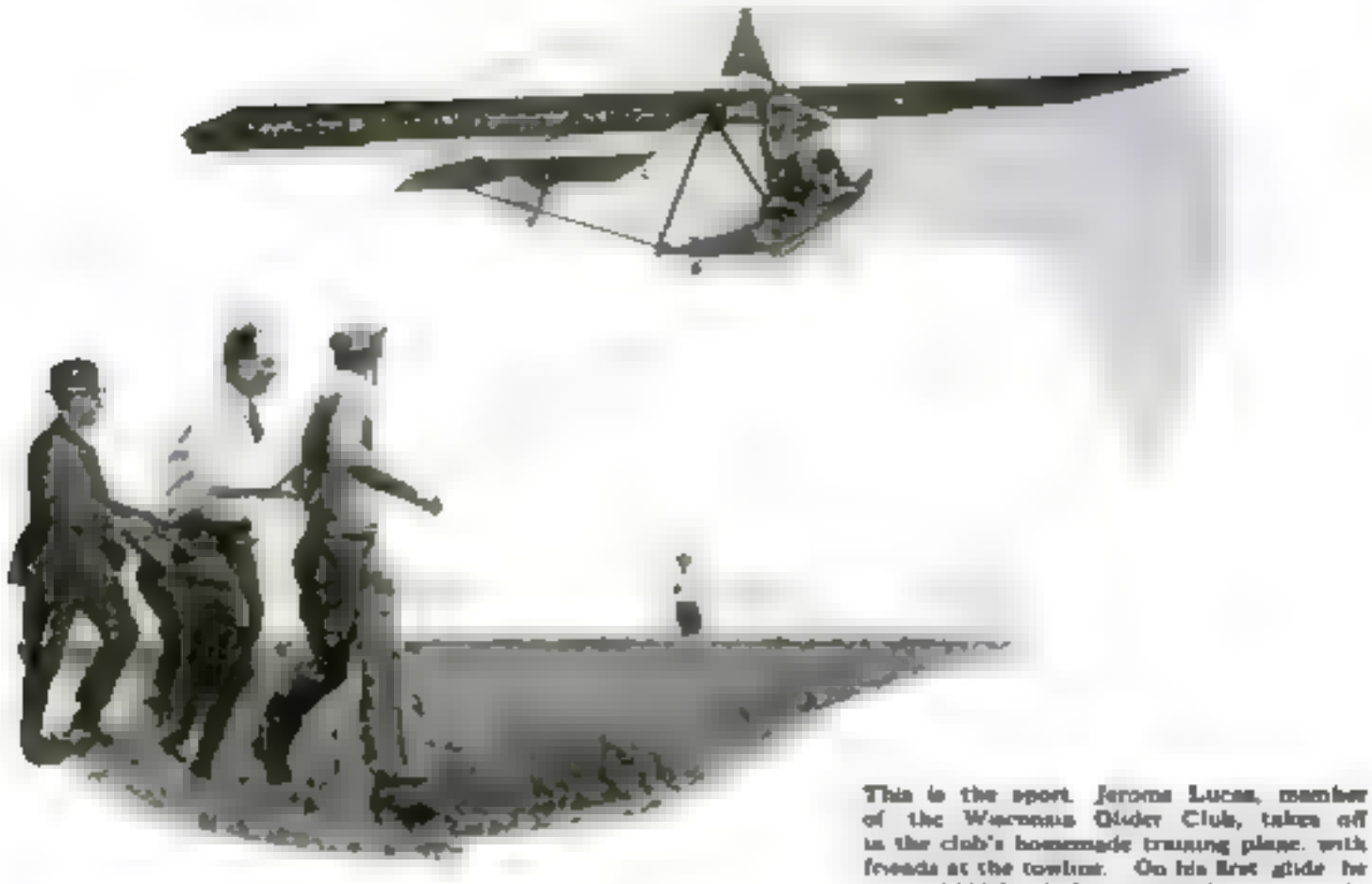
Giuseppe Bellanca, airplane designer. Flying cured his ills.

By the time Powell was ten years old, he could name all of the constellations in the northern hemisphere and also knew the positions of many of the stars that bore only numbers. Later, when a student in the University of Virginia, the study of astronomy was his particular delight.

Some years afterwards, Powell was bound for Europe on a concert tour. Aboard the steamer the conversation centered on the subject of comets, due to the fact that a comet had just flashed into view. It led to a discussion of why a comet travels tail first after it has passed the point where it is nearest the sun. The most popular theory offered in explanation at the time was that the light from the sun exerted a pressure on the gaseous particles in the comet and, like a wind, kept blowing the tail away from the nucleus.

Powell, however, was not satisfied with this hypothesis. He tested the theory with mathematical calculations and found it wanting. Shortly after his arrival in Europe, the musician, walking in a park in Vienna, was watching a Ferris wheel. He noticed that the motion of the device was based on the principle that the heavier part of the cars always swings toward the center of the wheel. Suddenly, the idea occurred to him that here was a striking analogy with the position of the moon in relation to the earth. The fact that we always saw the same face of the moon was due to the fact that one half of the satellite must be heavier than the other, and because of the attraction of gravity, this heaviest part must be turned toward the earth. (Continued on page 140)

John Powell, noted American musician who has won distinction as an astronomer.



This is the sport. Jerome Lucas, member of the Waconsta Glider Club, takes off in the club's homemade training plane, with friends at the towline. On his first glide he covered 100 feet before coming down to earth.

Motorless Plane Climbs a Mile

American Glider Pilots Try for New Records in the Growing Sport of Riding Air Gusts

By EDWIN W. TEALE

A GERMAN glider pilot, the other day, soared to a height of more than 6,000 feet with no other motive power than rising currents of air. It was the unofficial altitude record for motorless planes. The man who set it was Max Kegel, champion of a spectacular new air sport, "cloud flying."

Under every drifting cloud is a column of rising air. The "cloud flyer" takes off from a high hill in his featherweight motorless plane and jockeys it into one of these columns, which carries it aloft. Gliding down to the next column, his plane is carried upward again. In this way, he flies for miles across country and often climbs several thousand feet.

In Germany, more than fifteen thousand people of all ages have taken up the sport of motorless flying, and, in America, glider clubs are being formed from coast to coast. The American Motorless Aviation Club, of New York City; the National Glider Association, of Detroit, and the American Glider Association, of Dearborn, Michigan, have been formed to sponsor and encourage the sport.

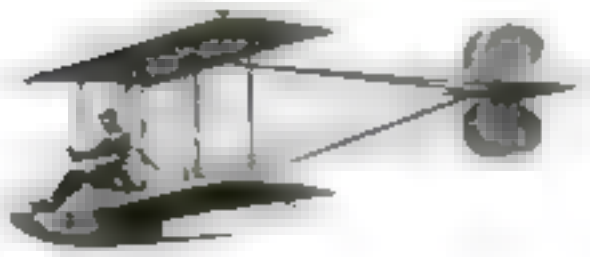
At Cape Cod, Mass., a school for soaring, under the auspices of the American Motorless Aviation Club, is in full swing. Homemade motorless planes are appearing on hillsides in such scattered parts of the country as Morristown, N. J.; Cincinnati, O.; Kansas City, Mo.; Breckenridge, Tex., Long Beach, Calif., and Seattle, Wash.

A German motorless plane soaring over the roof tops of St. Andreasberg in the Harz Mountains, during a winter practice flight. Above: Unusual photo of a glider crashing on one wing tip during a California glider meet.

Two German experts, Rolf von Chlingsperg and Heinrich Knott, have come to the Cape Cod school to instruct students in the fine points of riding air currents. At least a hundred of the birdlike German machines are expected to be imported into this country this fall. Besides, half a dozen factories here advertise motorless planes for sale, and one company in Wichita, Kan., recently announced a line of all-metal gliders to be placed on the market soon.

AT LONG BEACH, Calif., last spring, a national glider meet was held. One of the contestants, Dale Drake, hitched his motorless parasol plane to a Fokker airplane by a 500-foot rope and was towed all the way from Reedley, Calif., to Long Beach, 200 miles. At one point, plane and glider climbed 7,500 feet to pass over the Sierra Nevada mountains. Just

as the machines were leaving the pass, the towrope broke. Several hundred feet of it dangled from the glider's nose, puling it down. In spite of this handicap, Drake sailed for nineteen miles to a safe landing in a field. The next day he completed his journey!



Anthony H. G. Fokker, famous airplane designer, taking off in a glider of his own design. He was the first pilot to carry a passenger in a glider, in 1922.

IN "HITCHING" a ride behind a plane, Drake was following the example of Gottlieb Espenlaub, German glider pilot whose daring led him to perform the stunt which never before had been attempted. There is a dramatic story behind Espenlaub's rise in the glider world. A poor boy, living near the Wasserkuppe Mountain, he watched the Rhoen gliding contests near his home for several years. Then, during the winter of 1923, he built a soaring plane of his own design in a shed back of his home. The following summer, the homemade craft defeated many of the finished factory gliders entered in the meet. Since then, he has become one of the foremost sailplane pilots of the world.

Recently his feat was surpassed. Two gliders, one behind the other, were towed over a German air field, the pilots cutting loose and sprailing to a landing, one by one. Experts predict that long strings of gliders will form the "aerial freight trains" of the future. Carrying their cargoes, they could be cut loose and landed at destinations along the route.

Instead of an airplane, a fast motor boat was used a few weeks ago by Thomas D. Stimson, Seattle gliding enthusiast, to tow a soaring plane. In his motorless craft, Stimson has achieved two half-hour flights.

EARLY in July Colonel Lindbergh made his first flight in a glider before 10,000 spectators at St. Louis. Though he never had seen a glider flown, he soared the length of the Lambert-St. Louis flying field, about half a mile, and rose to a maximum height of sixty feet. For starting power, the glider was hitched to the rear of a friend's automobile by a sixty-foot rope. As soon as he rose into the air the rope was released and away he flew, controlling the machine perfectly without having received any special instruction.

The longest overwater glide yet attempted is to be tried soon by Hans Richter, pioneer German "glideflyer." He proposes to sail clear across the English Channel. For the purpose, he has designed a gull-shaped machine with a wing spread of thirty-five feet and a weight of only 165 pounds. He plans to be catapulted into the air by an immense rubber slingshot from the bluffs near Calais, on the French side, and to soar across the twenty-two miles of water to the cliffs of Dover. If he succeeds, he will follow almost the exact air lane blazed by Louis Bleriot in his memorable airplane Channel crossing in 1909.

A distance three times that across the Channel was covered not long ago by Robert Kronfeld, who soared for sixty-six miles over mountain ranges in West Germany. He used a sailplane built by Kegel, the cloud flyer.

German soaring pilots have set other remarkable records. Last spring the late Ferdinand Schulz, ace of sailplane drivers, flew for fifteen hours and five minutes without a motor. On another flight, he circled above the dunes on the coast of the Baltic for more than nine hours, accompanied by a passenger. It was while carrying another passenger shortly afterward that the wings of his sailplane came off, hurling both men to death. Other German pilots have set the official altitude record of 2,700 feet, have flown for 300 miles before landing, and have carried two passengers for a five-hour air jaunt!

How are these records possible? An airplane must land immediately if its motor fails. How do motorless machines fly all day and cover hundreds of miles? In the first place they are perfectly streamlined, reducing resistance. Then, their light plywood and woven linen construction cuts weight to a minimum. Thus the machines can make drifting glides, advancing twenty feet for every one they descend. A sailplane can glide three times as far as an airplane. This enables it to travel from one rising air current to another with a minimum loss of altitude.

All record-making flights are over mountainous or hilly country, in windy weather. As a breeze strikes the windward side of a hill, it is deflected upward, forming a rising air current. The glider usually is launched from a hilltop by a dozen men, who run into the wind pulling the plane by a long rubber cable—a giant slingshot that sends the machine out into the rising air current. It soars high enough for a glide to the next hill, where it climbs upward again, as in cloud flying.

Carola Diehlmann, fifteen-year-old German girl, landing glider of her own design after three-minute flight with air gusts for power.

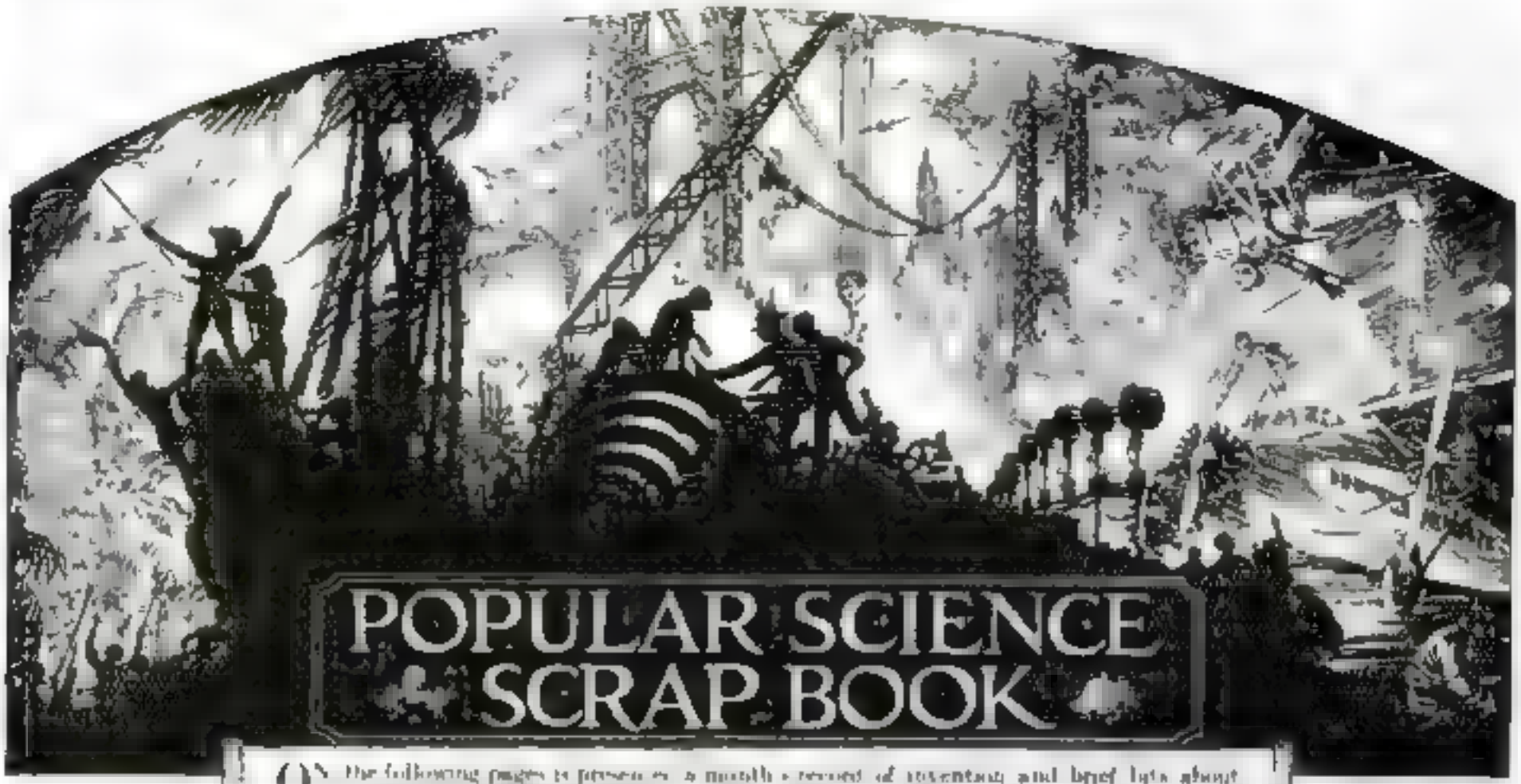
THE ordinary glider, or training machine, is not a soaring plane. It is launched from a hilltop and "coasts" down the air to land in the valley. It is started either by means of a rubber cable or by running with it and hopping off. In flight, the pilot balances it with an airplane control stick or, as in the older type machines, by swinging the body while hanging from armrests. Gliders of this kind are the only ones a beginner should attempt to handle. In similar ones, the great soaring pilots of today began their training.

"What does a glider cost?" and "How can I get in the gliding game?" are frequent questions. The cost ranges from fifty dollars, the amount needed to build your own training glider, to as much as $3,000 for a delicately constructed European sailplane. The best plan for getting into motorless flying seems to be to join, or form, a club. One member can go to a gliding school for expert instruction, and he can teach the others, who build or buy their machine, sharing the expense. At Detroit and at Cape Cod, schools have been established with expert instructors who hold the prized "Three Birds" insignia of the graduate German glider pilot. This is an enamel pin with three white gulls on a field of blue.

The first amphibian glider equipped with pontoons for landing on the water, demonstrated at a recent meet near Berlin. Curt Bornemann is the pilot.

ONE of the famous German schools which awards the "Three Birds" is at Rossitten, among the sand dunes on the Baltic coast. It was in this region that Otto Lilienthal launched the first man-carrying glider in 1891. For five years this retired German manufacturer continued his experiments. Then a fragile spar doubled up like a jackknife and he plunged to death. In those five years he was in the air a total of less than five minutes.

(Continued on page 155)



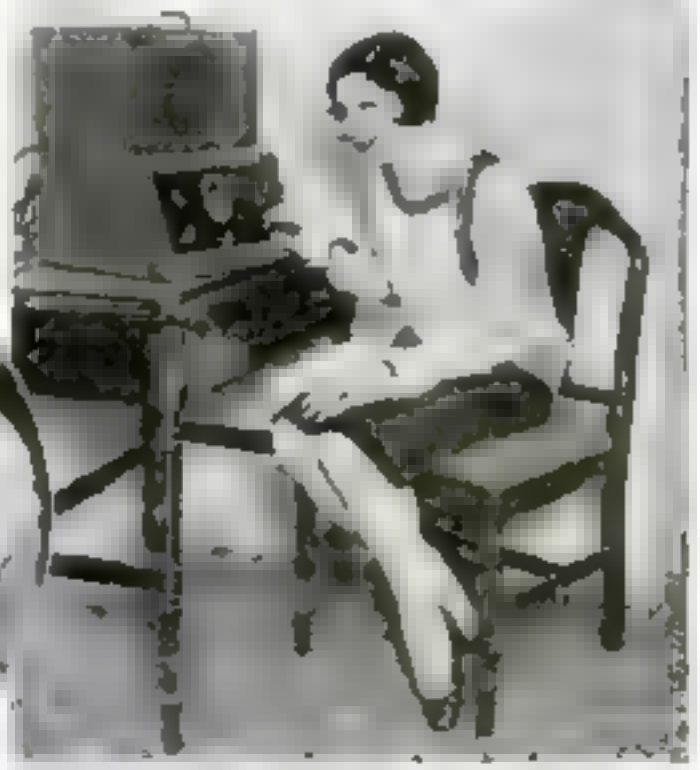
ON the following pages is presented a month's record of invention and brief bits about the new interests [illegible] of Popular Science are busy in all parts of the world.

Hotel's Steel Girders Carry Radio to Rooms

THE huge steel girders of a sky scraper skeleton now are being used to replace an elaborate system of wiring for carrying radio programs to the rooms of a New York City hotel. The inventors of the new system are Dr. F. L. R. Satterlee, a New York X-ray expert, and Louis Kalotay, a Hungarian engineer.

A centralized receiving station in the hotel contains six master receiving sets which tune-in on the programs of important broadcasting stations in the region. These programs are picked up by an ordinary aerial, as with the ordinary set. A series of radio oscillators connected with the receiving sets and also with the steel framework of the building send out new waves that travel along the steel beams to every part of the building.

All that a guest need do to obtain radio entertainment is to plug the room receiving set into a lamp socket which provides the necessary operating current, and to turn the dials to the station broadcasting the program he desires to hear.



At left: Connecting master receiver with steel framework of building. Above: A hotel guest tunes-in after plugging set into light socket.

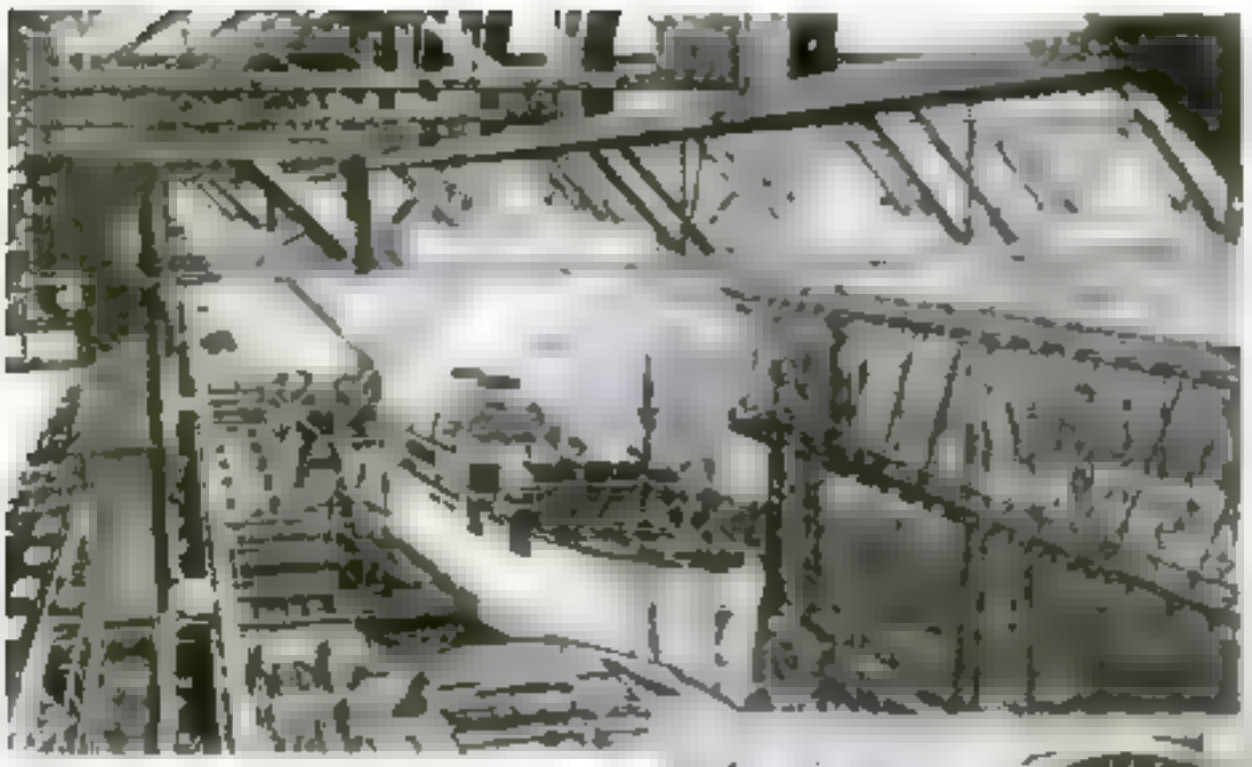
Co-inventors of new "guided radio." Above: Louis Kalotay adjusting master set that picks up programs. Left: Dr. Satterlee, with radio amplifiers.

Before the new system was installed only ten percent of the rooms in this hotel had satisfactory reception due to its location. The "wireless" method of distributing the programs to the rooms is said to reduce the cost eighty to ninety percent from that incurred in wiring the rooms for radio sets. The inventors call their new system "guided radio."

Dr. Satterlee says the invention soon will be incorporated in nearly a hundred skyscrapers in all parts of the country.

How Balloon Was Named

THE balloon got its name from a bottle. In 1783, when the Montgolfier brothers made their experiments with a bag filled with hot air, their invention was called a "balloon" because it resembled a large, round, short-necked bottle of that name, then used in chemistry.



Two Huge Diesels Drive Newest Motorship

A CRANK shaft almost as long as a freight car will turn [illegible] the world's largest Diesel [illegible] White Star motorships, [illegible] on its first homeward [illegible] Liverpool to New York. The [illegible] the largest [illegible] to Great Britain, having a length of 685 feet [illegible]

More than fifteen hundred passengers can be accommodated. The photograph above shows the 27,000-ton motorship under construction [illegible] Belfast, Ireland. What is [illegible] largest floating crane in the world was employed in placing machinery [illegible] in the hull. Each of the giant motors installed has ten cylinders.

Next winter the new *Britannic* will be used for two Mediterranean [illegible]

Gigantic crank shaft for one of two Diesel engines that drive the new British motorship *Britannic*

Inventor's Pocket Device to Predict Earthquakes

THE surface of the earth would be one vast ocean if it were not for earthquakes which, by producing mountain ranges and high levels, are responsible for the continued existence of the continents, in the opinion of the Rev. Francis A. Tondorf, seismologist of Georgetown University, Washington, D. C.

But while earthquakes are thus, in a sense, a necessary evil, science is constantly seeking means of preventing and alleviating the overwhelming losses of life and property caused by shocks.

A device which may prove useful in predicting earthquakes was invented not long ago by Albert Nodon, a French electrical engineer. The apparatus, as small and simple as a pocket compass, is said to be capable of measuring the intensity of the earth's magnetic forces as well as indicating their direction by a recurving magnetic needle which, in case of an approaching shock, begins to "dance" long before seismographs at observatories record the earthquake.

While the workings of the new magnetometer were not explained, its action is believed to be caused by the fact that the magnetic properties of the metal of which its needle is made change under the magnetic pressure produced by the earth's crust in advance of a quake.

Strange Porcupine Wears Rattles on Its Tail

A PORCUPINE with rattles in its tail and three birds similar in general appearance to a crow but with each tail feather shaped at the end like an arrowhead, were among the rare specimens recently added to the collection at the Field Museum, Chicago.

Known as "Diard's bird", the black birds from Asia were first brought to Europe in 1824, when one specimen was placed in a museum at Paris, France. At the time, it was suggested that the explorer who brought it back had cut its tail feathers in the unnatural shape to create a sensation. A hundred years later, a distinguished French ornithologist, Jean Delacour, brought five specimens to Paris. These six were the only ones known to have reached civilization until the William V. Kelley Roosevelt Expedition recently sent the first ones seen in America to the Field Museum.

The tail of the porcupine contains rattles different in construction from those of the rattlesnake, but which create a sound that cannot be distinguished from the warning of the snake as the animal moves stealthily through the grass.

Tide Carries the Mail

THE ocean tide is the mailman for the island of St. Kilda, north of Scotland. At this lonely spot there is no post office and no stamps can be purchased. So letters for the outside world are placed in tin cans, with the sums to pay their postage, and thrown into the ocean attached to sheepskin buoys with wooden floats marked "St. Kilda Mail. Please Open."

The ocean currents carry most of the missives to the Shetland Islands, where they are posted and carried by mail steamers to the mainland of England.

This Fisherman Has Something to Boast Of!

THE triumph of a whaler was caught by a photographer in the Arctic recently. Surrounded by six finback whales, their characteristically ridged bodies following along the sides of the ice-mantled whaling craft, he is pictured standing beside the harpoon gun that had helped in their capture.

The blanket of oil-producing blubber fat that covers the bodies of the sea monsters represents a value of several thousand dollars. This fat acts as an "insulating" layer to protect the whales from cold.

Because the capacity of water for conducting heat is twenty-seven times as great as that of air, they would lose immense amounts of their body warmth if they lacked the relatively nonconducting blubber.

A whale's eyeballs are immovable, and as they have acute hearing, it is a question whether they see or merely hear the things that attract their attention.

In a sea of whales. An Arctic whaler surrounded by six huge finbacks—the prize of an adventurous cruise in northern waters.

Heroine Who Risked Life for Science Rewarded

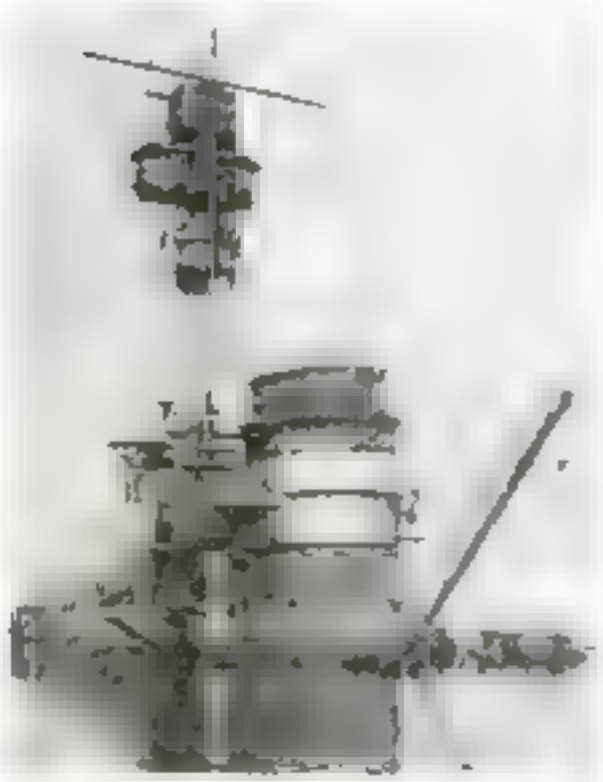
AS A reward for her heroic service to medical science, Congress recently granted a $125 monthly pension to Mrs. Joseph Goldberger, of Washington, D. C., widow of the late Dr. Goldberger, who, while serving with the U. S. Public Health Service, solved the mystery of pellagra, the skin disease that had baffled the medical profession for years. He found means to cure it and thus saved thousands of lives.

It was Dr. Goldberger's theory that pellagra was not transmissible, and to prove it he called for volunteers willing to be injected with substances taken from the bodies of pellagra patients. Several of the physicians of the Public Health Service offered their services, but Mrs. Goldberger insisted that she be allowed to submit herself to the test. Granting her request reluctantly, her husband hypodermically injected blood, taken from a woman who had died of pellagra, into the abdominal wall. Mrs. Goldberger did not become ill and the doctor's theory was vindicated.

Dr Goldberger discovered that pellagra, previously believed to result from the bite of an insect, was caused by deficiency in the diet and found the food elements necessary to combat the disease.

German Warship Salvaged from Scapa Flow

AFTER a dozen years on the bottom of the sea at Scapa Flow, north of Scotland, the dripping hull of the German dreadnought *Kaiser*, sunk by the Germans at the close of the war, recently was brought to the surface. The raising of this hulk is by an English concern is described as the greatest feat of salvage ever accomplished. Divers entered the hull and patched holes in the sides. Then compressed air was forced in, lifting the warship to the top of the water. Tugs dragged it to port, where it is being cut up so the armor and metal of the hull can be put to peace-time uses.



Fighting mast and funnel of sunken German battleship *Kaiser* appearing above the surface.

Capt. Vincent Taylor, Australian parachute jumper, dropping 135 feet from bridge over San Francisco Bay. Left: Chute opening at start of jump, which was completed safely

Parachute Jumper Leaps 135 Feet from Bridge

A RECENT plunge of 135 feet from a new bridge into San Francisco Bay, trusting to a parachute to break his fall, was regarded by Captain Vincent Taylor, of Australia, as a commonplace event in his adventurous life. He says he was making parachute jumps before anyone ever thought of a Caterpillar Club, that mythical organization of airmen who have saved their lives by relying on the silken folds of their 'chutes when planes become disabled.

The center section of a new automobile bridge across the bay, which can be lifted vertically to allow vessels to pass, was elevated to its highest point and the daring veteran, with floats tied to his waist, climbed down a rope and let go. An assistant above threw the parachute clear of the bridge to prevent fouling, and it opened immediately, slowing the fall so that the jumper was fished out of the water smiling and unhurt.

Orchard Pests Trapped by Lure of Geranium

ONE of the queerest trap lines in the world has just been laid in the District of Columbia. The trappers are Government experts of the Department of Agriculture, fighting the destructive orchard pests, the Japanese beetles.

Baited with extract of geranium, the "catnip" of the beetles, the traps attract the insects, which fly against a piece of [illegible] In good "trapping" locations, Dr. [illegible] J. Mallatt, in charge of the work, explains, it is not an unusual sight to see almost a quart of beetles in each trap at the end of [illegible]

The Japanese beetle cannot be eradicated by poisoning. When a tree is sprayed the cruelly insects flock to one that has not been treated and will return until rain has washed away the poison. The damage caused by these pests is mostly confined to the eastern fruit-growing states, particularly Pennsylvania and New Jersey, where they attack orchards, eating the leaves and in some cases even the fruit.

Stingless Substitute for Iodine Discovered

A NEW substitute for iodine has been discovered by Prof. Hans Fredenthal, Berlin University physiologist. He has called the new drug "metajodin."

According to its discoverer, metajodin has all the antiseptic properties of iodine, but does not sting when applied to open wounds. The new antiseptic is said to be made by combining iodine with oxygen.

Declares Cowards Are Ill and Can Be Cured

THOSE who "fight and run away" are sick, according to Dr. Ernest Jones, noted British psychologist, who says everyone in good health is naturally brave. Cowardice is a form of illness, he maintains, and can be cured by an expert physician or psychoanalyst.

Fear, or "anxiety states" of the mind, produce bodily reactions such as digestive disturbances and abnormal sweating, which show that the patient is suffering from worry entirely out of proportion to its cause. Even those who have proved cowardly in an emergency have often been cured of their fear and morbid anxiety by careful treatment, the psychologist states in his report.

Mechanical "Eye" Gives Slow-Motion Vision

The rotoscope. Moving objects are viewed through two eyepieces at top.

A MAGIC eye known as a "rotoscope," that weighs but seven pounds and may be carried in the hand, confers "slow-motion vision" upon its user. Observed through its eyepieces, whirling airplane propellers, spinning wheels, or gears appear as if they were standing still. Or, if desired, the instrument can be adjusted so that the motion is merely slowed down ten times or more.

With this new device it is possible to study the way that a pulley warps at high speed under different loads. It shows how far out of line vibration is shaking a piece of machinery. Another typical use is to make sure that when yarn in a textile factory is passing from one spindle to another both spindles are rotating at the same speed, since a discrepancy would weaken the yarn and also change its color in the dyeing process.

The instrument reveals astonishing glimpses of the world of high speed. In a cigarette factory, for example, engineers were surprised to find with its aid that a burring wheel they thought spun monotonously in contact with a knife blade actually bit it only now and then due to its vibration. In aviation, it may be used to set twin propellers to run in synchronism, or to measure the speed of one. Applied to gasoline motors, it disclosed the amazing fact that the springs on the cams do not expand immediately when pressure on them is released, but may be seen standing still for a split second.

The user looks at the wheel or other moving object through two eye slits. Within these, shutters driven by a powerful clockwork mechanism wink as many times as 4,000 a second! These winks at regular, adjustable intervals have the effect of slowing the motion as much as desired—even to a standstill. The principle is the same as that which produces optical illusions of the movies such as cause automobile and carriage wheels, at times, to stand still or run backward.

New Oxygen Tent to Save Pneumonia Victims

THE life of an eight-weeks-old baby suffering from pneumonia was saved recently in a hospital in Toronto, Canada, by the use of a new oxygen tent. The small victim, in the last stages of the disease, was placed inside an inclosure, given air with high oxygen content, and the congested lungs cleared up. The tent marks another step toward overcoming one of man's most deadly maladies.

If you imagine two large sponges alternately filling with water and being squeezed dry, you have a rough idea of how our lungs operate. They expand with air from which life-giving oxygen is extracted, and then contract, expelling carbon dioxide. When the lungs become congested, only part of the cells function so an increase in the oxygen taken in with every breath is important.

This is why pneumonia sufferers, in ordinary air, breathe faster. For each breath you take, your heart normally beats four times. During pneumonia, the ratio is one breath for every three, or even two, heartbeats. Greater oxygen content in the air permits slower breathing and thus saves the patient's strength.

Pneumonia sufferer undergoing treatment in oxygen tent at the Hospital for Sick Children, Toronto.

Poisons Cause Plants to Sprout and Bloom

POISONOUS chemicals will cause dormant plants to flower and bear fruit, and may, at some future time, free the farmer and the gardener from the tyranny of the seasons.

Dr. F. E. Denny, of the Boyce Thompson Institute for Plant Research, at Yonkers, N. Y., recently announced the results of a series of experiments, in one of which lilacs, through the application of poisonous fumes, were made to bloom at Christmas. Individual buds were treated with vapors from small test tubes attached to them with wax.

In another experiment, freshly dug potatoes were caused to sprout after an application of a poisonous chemical. The tubers, instead of being given their usual winter rest in the cellar, were soaked in sodium thiocyanate for one hour. In some cases, the potatoes were stored in closed containers for twenty-four hours after soaking, which further sped germination. Not only was sprouting rushed by the "poison process," but the potatoes were also made more productive, the "eyes" in some instances yielding from two to six shoots instead of one.

In all about 200 different chemicals were tested, among them ethylene, ethyl ene chlorhydrin, ethyl iodide, and sodium thiocyanate. The causes for the chemical changes produced in the plants, Dr. Denny said, cannot yet be explained. The reason for the dormant periods of plants, he added, is itself still a mystery.

Deep-Breathing Exercises Practiced by Ancients

"INHALE exhale," the directions used in setting-up exercises, are far from being a recent invention. Two thousand years ago, according to Dr. O. S. Johnson, of the University of California, the Chinese practiced deep breathing as a road to long life.

The ancient hygienists counted their heartbeats to time the holding of their breath. An old writer directs that 120 heartbeats should be counted before the breath is expelled, and after a long period of training, he says, a person should be able to count 1,000 heartbeats before releasing the air.

New Mechanical Man Obeys Beams of Light

TELEVOX, the mechanical servant, has a baby brother. It has been given the name "Telelux," because it is operated by light instead of by sound. The Latin "lux" means light, "vox," voice.

At an electrical exhibition at Pittsburgh, Pa., recently, Telelux was put through its paces, turning on and off lights and performing similar tasks, when commanded through light signals from the operator.

The "brain" of the robot consists of two photo-electric cells, able to translate light variations into corresponding electrical impulses. Thus when a light beam strikes the cells they actuate electrical relays which operate mechanical apparatus. Standing as far as seventy-five feet from the robot, the master of the mechanical man can give his commands by pressing the button on an ordinary flashlight, the number of flashes determining the task the machine performs.

Oil Well Still Produces After Sixty Years

THE "Old Faithful" among oil wells is located near Newhall, Calif. After nearly sixty years, it is still producing its four and a half barrels of oil each day. It was the first well sunk in California and led to the discovery of the rich fields on the Pacific Coast. All of the other wells which were drilled around the first have long since dried up. It stands like an old patriarch, toiling on after having yielded a total of more than a million barrels of "black gold."

A Mexican deer hunter is said to have stumbled upon the site. In following a trail through Pico Canyon, now in Los Angeles County, he happened upon an ooze of black, sticky fluid, some of which he took to a mission settlement at San Fernando where it was recognized as petroleum. A few years later, in 1870, a former resident of an oil producing district in Pennsylvania brought a crude drilling outfit to the spot and sank the famous well which has been working constantly ever since.

A Fish Small as an Ant

THE Philippine goby, besides being the world's smallest fish, is the tiniest backboned creature known to science. It measures only three sixteenths of an inch—the size of an ant! Only seventy-five specimens of the goby have thus far been caught and observed by scientists.

The championship is held only by the male of the species, the female being a little over a quarter of an inch in length. Besides being short, the goby's body is very slim and is virtually transparent. Its relatively large black eyes constitute its only really visible feature. This Lilliputian among fish is found in the tidal creeks north of Manila.

Balloon Signals "Quiet" over Talkie Studio

WHEN an orange colored captive balloon sways in the air high above a California movie studio it signals to airmen "Silence! Talkies being made below!" Flyers who see the balloon, increase their altitude or turn aside so as to pass no nearer the studio than 2,500 feet.

This novel aerial signal is the result of a recent agreement between motion picture producers and the California Aircraft Operators Association. The roar of powerful aviation motors passing close over a studio often causes the building to vibrate. Costly sound sequences in talking moving pictures are said to have been ruined in some instances because the sensitive microphones picked up these vibrations.

The agreement for the quiet zones stipulates that the balloons must be at least fifteen feet in diameter, red-orange in color, and must have attached to their mooring cables streamers of the same color. For night signaling, 1,000-watt lights must be displayed at the top of the bag. When the balloons have been let out to a height of several hundred feet they are clearly visible a mile away.

Captive balloon floating high above a California movie studio warns flyers that a talkie picture is being produced below.

Signal balloon on the ground ready to be sent up to its mooring cable.

Giant Crane Moves Along on Endless Treads

A MECHANICAL giant, with swinging steel arms hundreds of feet long, is tearing down a hillside and moving its soil to fill in adjacent swamp lands near Leipzig, Germany. Called the largest mobile crane in the world, it moves ahead on endless-tread tractors, which appear like pygmy machines below the central tower of the crane which rises more than 200 feet into the air.

Perched far out on one of the bridge-like arms of the crane, an operator seated in a control car governs the movements of the arms as they rotate, lifting cargoes of dirt at the embankment and dumping them into the swamp. The design of the huge crane is said to permit it to be knocked down and transported easily from place to place.

With enormous swinging arms, this mobile crane, called world's largest, is seen removing a hillside and depositing its soil to fill a swamp. It moves on endless treads.

Ant Cowboy in Steady Job

SIX-LEGGED "cowboys" of the ant world, that guard the "herds" of little green aphids which excrete a sweet "milk" prized by their keepers, were recently given special study by Dr. Herman Eidmann, of the University of Munich, Germany.

He discovered that only certain designated individuals in the ant colony are assigned to watch the herds of "cows." That the same ants return to the same twigs day after day was proved when Dr. Eidmann put colored paint on the different twigs and on the ants he first found there. Each day thereafter, the color of the twigs and the ants matched, showing that each insect was responsible for a certain definite territory.

Left Placing a message on the new Marconi transmitter which sends telegrams in facsimile instead of code Below The facsimile receiver At right is the light source which reproduces the transmitted image on sensitized paper

Receiving instrument of new Zworykin radiophoto system for transmission of photos and facsimile messages at high speed.

Photo Letters Sent in a Minute by Radio

IMAGINE a six-hundred-word letter traveling to a destination a thousand miles away in one minute! This is said to have been made possible through a new radiophoto apparatus invented by Dr Vladimir Zworykin, of the Research Laboratories of the Westinghouse Electric and Manufacturing Co East Pittsburgh, Pa. In one minute it can send a facsimile letter of 600 words, and will transmit a complete photograph in the same length of time.

An ordinary photograph or manuscript is placed on the cylinder of Dr. Zworykin's transmitting apparatus. As this cylinder rotates slowly, and at the same time moves forward longitudinally, a beam of light plays over the photograph, or message, whose patches of light and shadow are reflected by a system of mirrors to a photo-electric cell. This cell gives out electrical impulses corresponding in intensity to the light that reaches it These impulses are highly amplified and sent out in the form of radio waves.

AT THE receiving station, a standard receiving set picks up the impulses and carries them to a special lamp which flickers according to the fluctuations in intensity of the current. This light, focused in a beam, plays on a sensitized paper turning on a cylinder similar to the one at the transmitting station. A radio signal of constant frequency sent over the same wave length that transmits the picture, regulates the speed of the motor driving the receiving cylinder to synchronize with that of the sending machine. As the beam falls on the sensitized paper with varying brightness, it reproduces the lights and shadows of the original photograph or manuscript so that the developed paper reveals a facsimile of the image that is being transmitted.

In England, the Marconi Company, using improved apparatus, recently succeeded in transmitting two images, each eight by ten inches, in twenty minutes.

Takes a Census of Fleas

"AS LIVELY as a flea" does not apply to all fleas, according to Dr. C. L. Williams, of the U. S. Public Health Service, who recently made a "census" of the parasites found on ships entering the port of New York. Some fleas like to travel, others prefer to remain in one place, he found.

From 1,915 ships he obtained 7,880 specimens, nearly ninety per-cent of which belonged to a single variety. Most of the remainder were members of a second variety. The result of his investigation, Dr Williams declares, shows that fleas of only a few varieties are accustomed to travel, carrying diseases from one locality to another

Dr Vladimir Zworykin, Westinghouse engineer, with his high speed radiophoto transmitter

Builds Curious Clock in Old Chinese Armor

ARMOR that protected a Chinese warrior four centuries ago has been made into a unique clock by Fred W Jensen, of New York City. The metal pieces of the suit of mail, fitting together like scales of a fish, house a clockwork that moves the hands from one to another of the beads of small Oriental gods, used in the place of hour numbers.

As the clock operates the eyes in a mask face above the armor move from side to side and the teeth click together in time with the ticks of the strange timepiece.

Since 1892 Jensen has been repairing antique clocks and constructing unusual time recording mechanisms in his little shop facing the docks along the Hudson River. Some of these announce the hour through the singing of a flock of mechanical canaries. One timepiece is carved to represent a boy with pursed lips. At intervals he whistles an old German tune. Many of the clocks, elaborately carved, come from distant lands.

Fred W Jensen and his clock made of Chinese armor Small Oriental gods form the numbers.

Hot Water by Siphon

MUCH of the difficulty of an early-morning shave in Paris, where the hot water supply is limited, has been removed by the recent invention of a siphon that spouts hot water instead of soda. The device contains an electric heating element placed inside the metal tube through which the water is forced by means of a rubber bulb which resembles that of an atomizer

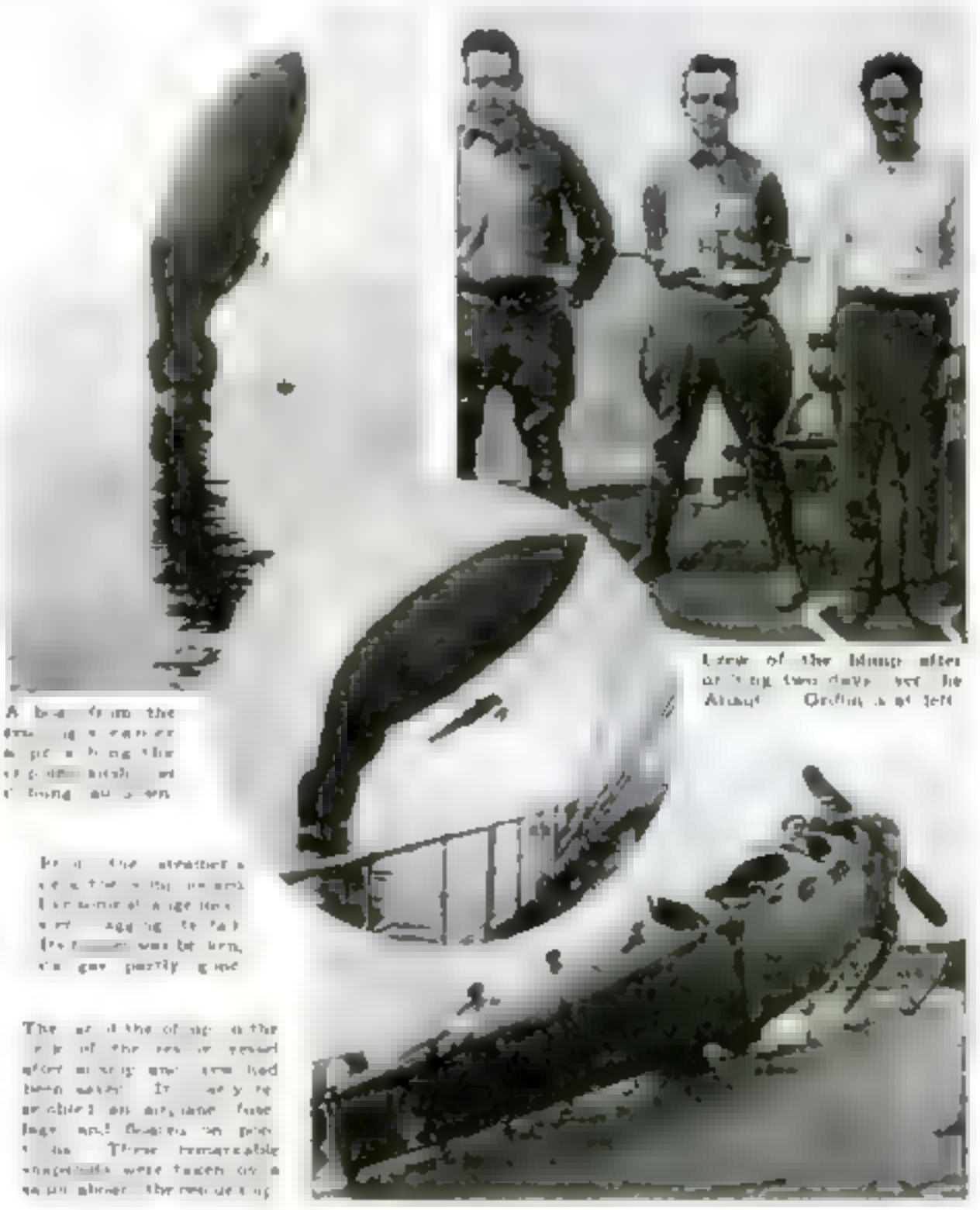
Adrift Over the Sea in a Crippled Blimp

DRIFTING helplessly out to sea in a crippled blimp, with two bombs on board and 90,000 cubic feet of inflammable hydrogen gas overhead, was the thrilling experience of three U. S. Army flyers during the war. The adventure was recalled recently by the arrival in this country of snapshots taken from the Norwegian steamer which effected the rescue. One of the sailors learned the address of the commander of the runaway blimp, Walter B. Griffin, now a member of the Goodyear-Zeppelin organization at Akron, Ohio, and forwarded the photographs to him

On a Saturday afternoon, the airship was cruising along the Massachusetts coast hunting enemy submarine raiders when the rudder broke and the motor, pulling the ship in circles, had to be shut off. The helpless gas bag drifted out to sea. Without radio, the men were unable to call for help. Soon the balloonet, a small bag within the envelope which is filled with air to maintain interior pressure, began to collapse. At the same time a motorcycle motor and blower, used to inflate the balloonet broke down. After working over it for hours, the men threw it into the sea to lighten the craft.

The balloonet flattened out and the gas bag began to double up like a jackknife, until the tail of the blimp dragged in the water. To keep afloat the crew lightened the craft by gingerly dropping the two bombs overboard. Luckily they gurgled to the bottom of the sea without exploding

Until late Monday afternoon the disabled airship dragged over the waves toward Europe. Then a Norwegian merchantman on its way to Nova Scotia steamed into sight and hurried to the rescue. After the gas had been valved from the envelope, the men and machine were fished from the ocean and carried to shore aboard the vessel.



Crew of the blimp after drifting two days, with Lt. Alfred Griffin, at left

U. S. Officials Honor Model Plane Champions

THREE record-holding aces of the model airplane world recently demonstrated their skill in flying their toy machines before Secretary of Commerce Robert P. Lamont and William P. MacCracken, Jr., Assistant Secretary for Aeronautics, at Washington, D. C. William Chaffee, junior outdoor champion, Thomas Hill, national outdoor champion, and Aram Abgarian, holder of the world's indoor endurance record, were the three boys honored. Accompanying them was Ford Grant, a model airplane enthusiast of Detroit, Mich. Hill lives in Winston-Salem, N. C. The other two champions are from Detroit.

Left to right: Ass't Sec'y W. P. MacCracken, Jr., William Chaffee, Secretary Lamont, Ford Grant, Aram Abgarian, and Thomas Hill.

Abgarian, whose single-propeller tractor monoplane last year left all other indoor endurance records far behind by circling in Olympia Hall, Detroit, for nearly six minutes, explained the construction of the featherweight planes to the Government officials.

All three of these record holders have been building models for years, improving their little craft and gaining the experience which enables them to get the most from the rubber strand motors which drive the planes through the air.

Dead Sea Contains Gold Worth Fifty Billions

FABULOUS wealth is contained in the Dead Sea, in Palestine. British chemical interests not long ago obtained a concession to exploit its vast mineral resources. The deposits of pure potash, bromine salts, gypsum, and magnesium chloride and other minerals valuable to agriculture and industry have been estimated to be worth twelve hundred billion dollars—three times the British war debt to the United States!

Just recently, Dr. Georges Claude, the distinguished French scientist, informed his government that the Dead Sea, in addition to the chemicals, contains fifty billion dollars' worth of gold! One third of this, Dr. Claude claimed, could be extracted by modern scientific means in about fifteen years.

Torch Gun Sprays "Paint" of Molten Metal

A NEW type of machine "gun" whose peaceful function is one of preservation rather than destruction has recently been invented in Germany. From this "gun" a fine metallic spray, consisting of tiny particles of zinc, aluminum, or other substances, is shot upon the surface of railroad and motor cars and even of entire bridges to cover them with a thin but durable film of noncorrosive metal that protects them from rust.

Inside the ingenious "metal atomizer" burns an intensely hot blowtorch flame. Thin wires of the desired metal are fed into the "gun," which first liquefies them and then sprays the metal, which hardens into a solid coating.

Bottle Drifts 8,300 Miles Across the Pacific

AN 8,300-MILE voyage by a tiny "ship" of glass was recently reported by the U. S. Navy's hydrographic office in Washington, D. C. On September 27, 1927, an officer of the American steamer *K. R. Kingsbury* tossed a bottle, containing a message giving the location of the ship, into the Pacific off the coast of Lower California. Seventeen months later, on February 12, 1929, it was picked up in the Philippine Islands, 8,300 miles away. This sets a record for a bottle drifting in the Pacific and is believed to be about the longest distance possible in that body of water.

The greatest voyage ever made by a floating bottle was 11,820 miles, beginning in the southern Indian Ocean and ending at Cape Horn, at the southern tip of South America. The record-breaking drift began in May, 1909, and ended in May 1912. Less than three hundred miles behind this record is the distance made by another current-carried bottle which started in 1902 and floated 11,550 miles before it was picked up in 1905.

Each year, sailors drop thousands of bottles into the seas at far corners of the world as part of the work of charting the ocean currents and solving some of their mysteries. The records of bottles picked up are filed by the hydrographic offices of the various nations.

Lamp Shows Lost Motions

SCIENCE has invaded the kitchen in Germany and given rise to a new profession, the "household engineer." Dr. Max Mengeringhausen, an efficiency expert, recently reported successful results from experiments designed to reduce the waste motions of housewives. He placed a small lamp on the wrist of a woman while she was engaged in making pies. A camera was so arranged that it recorded every movement of the woman's wrist in lines on a photographic plate. When these were studied, they revealed the different motions necessary for the operation, and suggested how more convenient kitchen equipment and better organization of the work might reduce the fatigue involved in kitchen labor.

Amateur Aviator Builds Plane in His Parlor

THE story of John Ericsson developing his screw propeller in a bathroom workshop is no stranger than that of Peter Lepnier, an amateur aviator of Brooklyn, N. Y., who built his airplane in a parlor. In this queer nest for a flying craft, Lepnier worked evenings for more than a year. He even got in extra time at noons, eating his lunch as

carried them away to be assembled at a flying field for the first test.

Keeps Trousers Creased

PERMANENT creases can be put in trousers, M. M. Munsch, a French inventor, maintains, by the use of a new chemical preparation he has discovered. A narrow strip of the plastic material is placed down the inside of the trouser leg where the crease will be formed. The material softens when a hot iron is run down the outside of the cloth and later cools and hardens, holding the crease in place, he says. If the owner ever desires to remove the chemical substance, he can do so by heating it, according to the inventor.

Sieves Salvage Diamonds in Air Mail Wreck

TALES of treasure lost in ships sunk at sea recently found a parallel in the wreck of an air mail plane near Dixon, Ill. When engine trouble developed the pilot jumped with his parachute and the machine, carrying more than $25,000 worth of black diamonds, crashed into a swamp and burned. An insurance company paid the owner of the diamonds for his loss and then set about to recover the stones.

The soil under the wreck, to a depth of several feet, was removed, dried, and sent to New York City, where it was sifted. Forty percent of the stones were recovered in this manner. Several weeks later, after heavy rains, other stones appeared where the wreck occurred and were picked up by a laborer, hired to continue the unique diamond hunt.

The chief use of black diamonds is in boring into the earth in prospecting for precious minerals. Attached to the end of a hollow pipe is the [illegible] inch and a half [illegible] diameter with eight of the black diamonds in [illegible] edge.

Names, Like Hats, Change Style

NAMES [illegible] people as well [illegible] and have the changing [illegible] by Professor George R. Stewart, Jr., of the University of California has revealed. Studying the records of the university officers and students over a period of years, he found cycles in the popularity of different feminine names. Elizabeth holds first place in favor at present. Mary was the favorite a few years ago. The Mabels, Anns, and Emilys have recently grown fewer. In the future, he predicts, Frances will rise to first place, with Ann and Emily coming back into favor.

Professor Stewart selected twelve feminine names which have been consistently popular for the last fifty years. They are: Elizabeth, Mary, Helen, Dorothy, Margaret, Marie, Katherine, Louise, Ruth, Eleanor, Lucille, and Evelyn.

Tusks of 4,000 Elephants Supply Billiard Balls

THE tusks of 4,000 elephants are needed each year to supply the world with billiard balls, which cannot be made from any substance except ivory. Most of the material, gathered from dead elephants found in jungles and on feeding grounds, is sent to London, whence it is reshipped to Hamburg, Germany, the world's chief ivory market.

Much time and care and the utmost skill go into the making of the billiard balls, which are valueless unless they approach perfection in shape, size, weight, and smoothness of surface.

The tusks are weighed and measured with great care and cut into oblong blocks. They are then placed in a seasoning room, the temperature of which is painstakingly regulated to prevent cracking of the ivory. After a year in the seasoning room, the blocks are shipped to the factory. Here they are cut again, this time closer to their ultimate shape, and stored away for another year's seasoning. Of all the tusks which have been stored in the course of seasoning and shipping, one-half are lost. The average billiard ball costs about $60. The finest are Zanzibar ivory balls, worth from $80 to $90. They require several years' seasoning.

The new car being started by one of its designers. Compare the height of the car with the driver's head. Driver is shifting gear shift on dash

New "Dachshund" Auto Has Front-Wheel Drive

ON THE highways near Pasadena, Calif., a mystery automobile with a question mark in place of a name plate was recently tested. As wide and as long as the usual car, it is so low that a medium-sized man, standing beside it, could rest his elbow on the roof of the inclosed body. No running board is necessary. The driver and passenger step directly into the low machine.

Inside, the operator shifts gears, not by the usual lever, but by a sliding mechanism on the dashboard. The car is driven through the front wheels, the power being transmitted to the front axle by a short drive shaft and universal joints.

In a test run, the strange "dachshund auto" is said to have reached a speed of ninety miles an hour on a concrete highway. The coupe weighs 2,500 pounds and has a 130-inch wheelbase. Its low rakish lines represent the latest development in the general trend toward low body design, which is made possible by modern smooth highways.

First Motion Picture of Sunrise on the Moon

YOU'VE seen countless terrestrial sunrises and sunsets in the movies, but it has remained for the Princeton University observatory to take motion pictures of the sunrise on the moon. With the twenty-three-inch lens of the telescope substituted for that of the camera, the burst of dawn on the peaks of Copernicus, one of the moon's 200,000 craters, was caught for the first time. This feat, one of the most important of recent achievements in astronomy, may mean that the wonders and secrets of distant worlds will be brought to the neighborhood movie

[illegible] bringing to everybody [illegible] of observatory [illegible]

Flashed upon the screen, the pictures showed a lunar sunrise of [illegible] miles apparently only [illegible] miles away instead of the [illegible] Dodging about [illegible] [illegible] [illegible] the face of the moon at only nine miles an hour, compared with 1,000 miles an hour on the earth, the pictures were taken at a speed of one hundred times less than the ordinary film, or one picture every six seconds. Run off at the regular speed, the pictures revealed in two minutes a phenomenon which actually takes more than three hours.

Because of the lack of atmosphere on the moon, there is no twilight to its dawn. A bright rim of light pushes back the blackness of night in a sharp line. This light was seen to climb the giant walls of Copernicus crater, rising about two miles above the surrounding plain. Great shadows extended into the huge pit, which is 9,000 feet deep and sixty-four miles across. Gradually the giant shadows shortened and sunlight poured in to fill the gigantic cuplike depression.

"Hold It, Please!" The Sea Lion Strikes a Pose

BEING photographed has become such an everyday occurrence for the sea lions in the London, England, zoo, that they often approach within a few feet of the photographer to pose for a close-up. Balancing themselves with their armlike flippers on the rocky edge of the pool, they twist and turn, examining the camera with great curiosity.

Because of their intelligence, these animals are prized for menageries and zoos. Unlike their relatives, the seals, sea lions do not have fur. Their thick skin is covered with coarse hair. The great yellow sea lion, a rare species, sometimes grows to a length of twelve feet.

In former days, these sea monsters were valued highly by natives of the Pribilof Islands, off the coast of Alaska, who made raincoats from the linings of the intestines and constructed boats by stretching the tough sea lion skin over a wooden frame. The common sea lion is smaller, usually about seven feet long.

One Half of All the Rain Goes Back to the Air

WHERE does all the rain go? A three-year study by the U. S. Geological Survey has answered this question. The Pomperaug Basin, in Connecticut, which is believed to be typical of the country at large, was given intensive study. The results showed that of the annual rainfall of forty-four inches, twenty-one inches flow out through streams. The other twenty-three inches return to the atmosphere. Evaporation from the soil, from water surfaces, and from the leaves of trees account for these tons of moisture that enter the air.

Lives with Rubber Heart

REMOVING the heart from a cat, substituting an electrically operated double-action rubber pump for the organ, and thus not only reviving the animal but keeping it alive several hours, was the startling experiment conducted some weeks ago by Dr. O. S. Gibbs, professor of pharmacology in Dalhousie University, Halifax, Nova Scotia.

The investigator devised the test during experiments to ascertain the effects of various poisons on parts of the body after the heart had succumbed. While recognizing the importance of Dr Gibbs's experiment, medical authorities emphasized that the invention was inapplicable to human beings.

Greatest River Chain Is Revealed by Explorers

A DISCOVERY in South America which reveals the world's greatest chain of rivers was made recently when two German explorers in the wilderness of Paraguay found a connecting link between the mighty Amazon and the rivers which wind to Rio de La Plata. Geographers long had believed that there was a canal or link between the two great rivers of South America, but no definite proof had been advanced.

It is now known that one tremendous system of rivers extends from the mouth of the Amazon, at the equator, to Buenos Aires, thousands of miles down the east coast. A short distance south of the headwaters of the Amazon begin the rivers which flow straight south to Buenos Aires. The new discovery will not add to the 50,000 miles of inland navigation afforded by the Amazon and its tributaries. Brazilian river steamers ascend from Buenos Aires 2,360 miles to within a short distance of the headwaters of the Amazon. The district between the two rivers is known as "the Diamond Province of Brazil." Prospectors "wash" for diamonds as the "Forty Niners" washed our rivers for gold!

Aluminum Replaces Wood in Office Chairs

ALUMINUM is taking its place beside mahogany, walnut, oak and birch as a material for building chairs. One company in Buffalo, N. Y., is producing 3,000 aluminum office chairs a month.

An aluminum alloy that has approximately the strength of mild steel is used. The weight of an aluminum chair is about one half that of the same type of chair made of wood. Seats of this kind are expected to find wide use in dirigibles and airplanes, as they are stronger than the wicker furniture now used.

Flames of Star Speed 4,000 Miles a Minute

FLAMES that travel 4,000 miles a minute have been found in the giant sun, Beta Cephei, which shines near the North Pole star. From a size of 10,000,000 miles in diameter this great star swells, in a little more than four hours, to a flaming ball 11,000,000 to 12,000,000 miles in diameter.

Recent studies at the Fuertes observatory of Cornell University have attempted to explain the pulsations by which stars such as this rapidly expand, then as quickly shrink to their original size. Though no one knows what started this movement, the principle that keeps the flaming gas in motion is like that of a pendulum. Someday, astronomers say, the motion will stop, pendulumlike, midway between the two extremes.

New Movie Camera Records Scenes in Perspective

MOTION pictures in natural perspective were thrown on the screen during a recent demonstration of a new system of photography and projection developed by George K. Spoor, veteran producer (at the right in the photograph), and John J. Berggren, an inventor (left).

The film used is double the normal width, and the camera is equipped with two lenses spaced about the same distance apart as the human eyes. The inventor says the perspective effects are obtained by mirrors within the camera which bend on the film the images produced by the lenses.

The new system would permit the lifelike production of many scenes now hopeless from a movie standpoint.

Strange Mineral Produces Useful "Offspring"

A SCIENTIST recently placed a small cube of whitish "rock" in a dish of water in his laboratory. Thirty-six hours later he returned and found that the cube had bred a whole family of other cubes! As the mineral swelled in the water, each face except the lower one, which was protected from the action of the fluid, produced a new cube as large or larger than the original! Other types of the same mineral expand into irregular shapes ten times their original size under similar conditions.

The whitish substance is bentonite, one of the oddest minerals known. Only recently scientists have begun to discover the extent of its usefulness. In the days of the California gold rush, the "Forty-Niners" soaked bentonite in water to make a soap they dubbed "surface jelly." Deposits in the United States, Mexico, China, and France, of volcanic origin, lie near the surface and are "mined" with plows, scrapers, and steam shovels.

Research chemists for oil companies recently found that bentonite filters crude petroleum more quickly and more cheaply than fuller's earth, the substance formerly used for the purpose. It may also prove valuable in redeeming waste by filtering and purifying used motor oil.

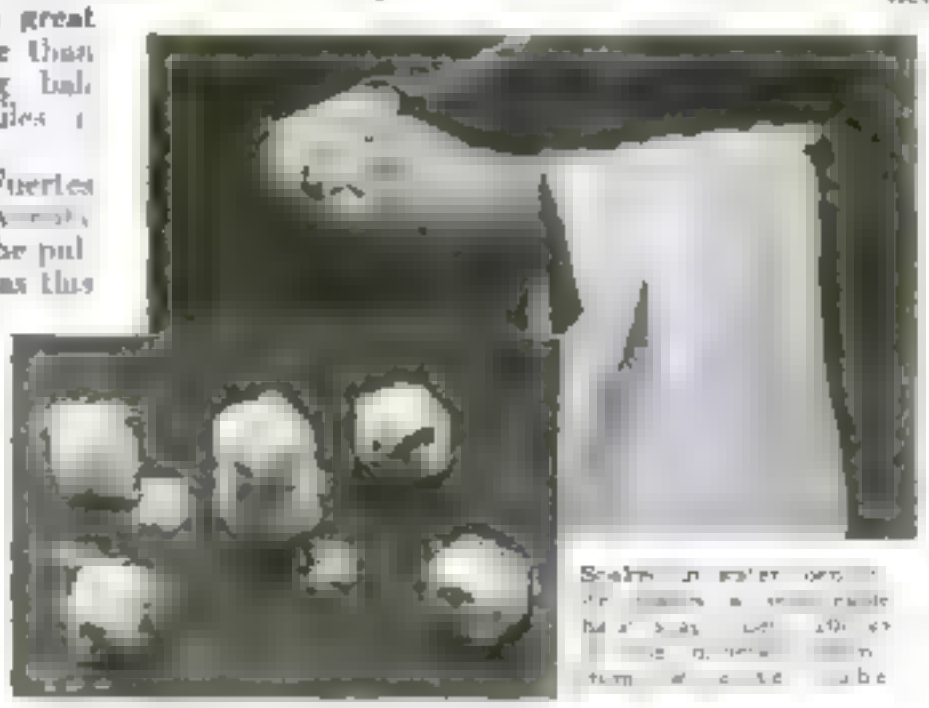
A discovery made by a boss molder in a Milwaukee, Wis., foundry, gave the strange mineral another new job. He found that molding sand, which is usually thrown away after being used once, because the clay coating on the grains is burned into material resembling earthenware by the heat, can be given a new coating by washing it with bentonite. His method is being adopted by many companies.

In soaps, cleaners, and beauty preparations, bentonite has found a place as an ingredient. It also has been used in surgical dressings. In sprays it promotes emulsions and aids in fighting destructive insects. As a plastic filler it is employed in the manufacture of linoleum, window shades, and phonograph records, and it also has its place in polishing shoes.

Edison's First Lamp Is Pictured on Stamp

A PICTURE of Edison's first electric lamp was placed recently on a special two-cent U. S. stamp. Edison's portrait could not be used because of a general rule against portraying living persons on stamps or money of the nation.

The lamp is one of the few inventions to be honored in this way. While airplanes, steamboats, bicycles, and railway trains have appeared on U. S. stamps, they have been placed there because they are means of transporting mail rather than because they are inventions. Last year a picture of the Wright brothers' first airplane appeared on a special stamp commemorating the twenty-fifth anniversary of the first flight.



Hunt Whales by Plane

AFTER seeing the North Pole from the air, Capt. Hjalmar Riiser-Larsen and Capt. Luetzow Holm, veterans of the Amundsen-Ellsworth 1926 flight from Spitsbergen to Alaska in the dirigible *Norge*, are setting out to hunt whales in airplanes. A Norwegian concern has hired the famous airmen to accompany the steamer *Thorshammer* on its annual cruise into Arctic waters. They will circle away from the ship, signaling back the position of whales seen.

Walls Insulated with Lining of Seaweed

"SEAWEED quilts" form the unique insulating material recently used to line the walls of a new bank building erected in London, England. After long green ribbons of the sea plant had been dried and put through a special process, they were "quilted" in sheets about the width of ordinary wall board and attached to the walls to form an insulating lining under the plaster.

The "quilts" are reported to be effective in deadening sound and protecting the interior of the building from heat and cold. This latest utilization of seaweed, of which there is a limitless supply in every ocean, will be given additional tests to determine its value in house building.

Find Lost Village Buried by Sand 400 Years Ago

FIRESIDE legends in northern Germany for nearly four centuries have told of the lost village of Lonske, which was swallowed by a mountain of moving sand. The other day, remnants of the village were discovered in the wake of a drifting sand dune on the Baltic seacoast of Pomerania.

About 1540, this little fishing village stood on the coast with a great dune between it and the sea. As prevailing winds blew in one direction, the sand particles were carried away from the sea and the whole gigantic mound worked gradually inland, burying the homes of the fisherfolk, who abandoned the village and moved elsewhere. The advance of the drifting dune was so gradual that no life was lost in the destruction of Lonske. In the time that has passed since that day, the dune has moved farther inland, until now parts of the buried homes have come to light.

German antiquarians, searching the spot, have found bits of timber, household utensils, and even the coins of forgotten German princelings of the fourteenth and fifteenth centuries. They report that the sand-preserved relics may prove a valuable archeological find.

During the laying of a new bank building in London with seaweed quilts, these workmen are said to shun no task as well as treat an [illegible]. Right, Other plants in the seaweed used in new wall insulation

Round-Up of Wild Horses a Thriving Industry

THE tops of your shoes, your soap, and the feed for your chickens may have had their origin in wild horses roaming the deserts and plateaus of the Far West. For an industry which captures, kills, and markets thousands of wild horses annually for these products has grown up in Montana, Idaho, Nevada, Utah, California, and Oregon.

Round-up parties go out in search of the herds, which are usually found in the early morning around water holes. The riders form a circle and close in on the animals, driving them to a corral. The tallow is sent to soap factories, the hides made into leather, the meat converted into chicken feed, and the bones are used as [illegible] fertilizer. The value of each horse is determined by the quality of its hide. They bring from $2 to $5 apiece.

Wild horses are just as wild as deer, and they can detect the presence of a man at great distances. They are so speedy that riders have to change saddle ponies every other day during round-ups. Cattle and sheep owners say they are glad to have the wild horses killed, because they eat twice as much as a cow and six times as much as a sheep. They can withstand severe weather and if necessary they are able to go without food or water for a long time.

Handwriting Reveals Sex by Slants and Curves

THE handwriting of men, as a rule, is angular, irregular, unconventional, and possesses an individual slant. That of women, on the other hand, is usually curved, conventional, and uniform.

Those were the conclusions reached by members of the faculty of the California State Teachers College at San Diego, who recently conducted an experiment to determine whether sex characteristics in handwriting could be readily recognized. The experimenters selected a number of judges who had no special training in penmanship and to them submitted a large sheaf of handwriting samples. Two out of every three of their decisions as to the sex of the writer proved to be correct.

Burned by Glacier Ice

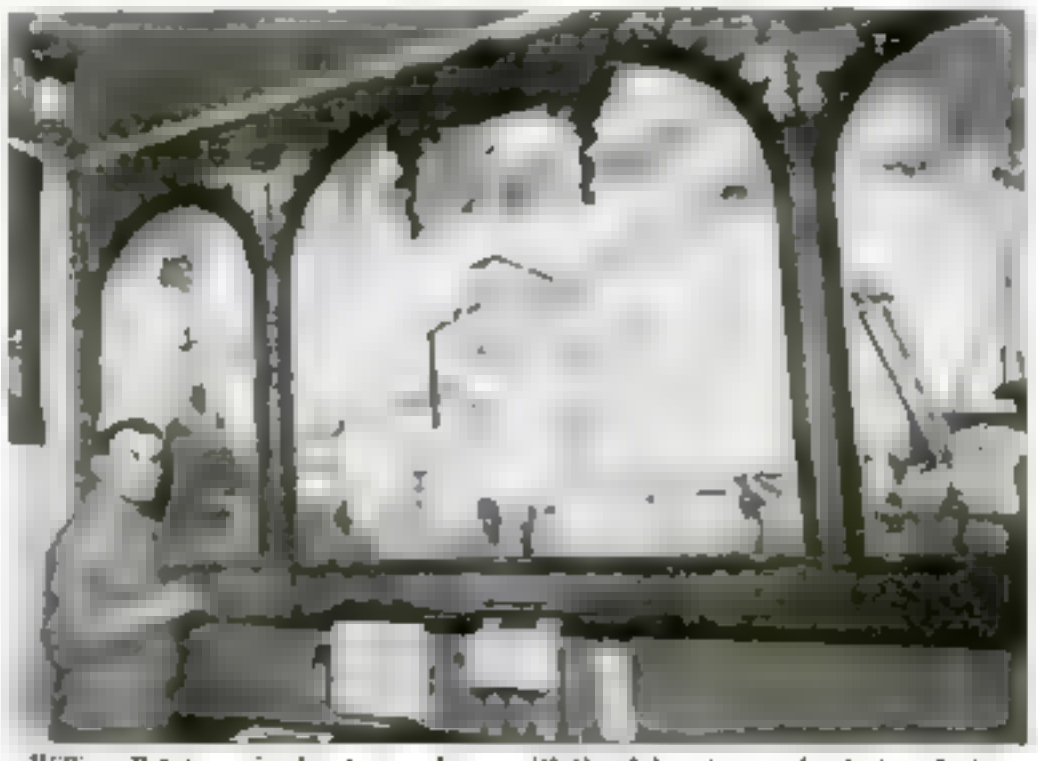
PORTLAND, Ore., high school boy recently suffered the unusual experience of being burned by ice so severely he had to be taken to a hospital. Climbing Mount Hood glacier, he lost his footing and slid 2,500 feet down the gleaming mountain side. He was picked up in a crevasse with no bones broken but burned by friction as badly as if by fire.

Grain Elevator Has an Artist

IN MOMENTS snatched from his work as a weigher in a grain elevator at Brooklyn, N. Y., William Peters has painted on his office wall an elaborate mural which represents the progress of transportation from the oxcart to the Zeppelin and the seaplane.

In the center of the design is a picture of the high, white elevator in which Peters works, keeping record of the millions of bushels of grain entering from the barges brought down the New York State Canal.

All his life, Peters says, he has wanted to paint, but has never had time for study. His natural aptitude with the brush enables him to find relaxation from the dust and roar of the huge elevator. His twelve-year-old daughter has inherited his talent for painting and plans to be an artist when she grows up.



William Peters, grain elevator employee, with the elaborate mural painting, depicting the progress of transportation, which he completed during odd moments.

Oaks Popular

MORE oaks are planted along streets and roadsides in the United States than any other kind of tree, the Bureau of Public Roads reports. Maples hold second place in popularity. In cool and dry regions, the green ash, locust, hackberry, box elder, and poplar trees are in wide use. In warm, dry climates the eucalyptus, palm, and Jerusalem thorn predominate.

Largest Motor Lifeboat Carries 300 Persons

THREE hundred people can ride in the *Princess Mary* said to be the largest motor lifeboat ever built recently tested at Cowes, Isle of Wight England. Equipped with radio apparatus, the craft will be stationed at Padstow Cornwall, near the southwestern tip of England, as part of the equipment of the life-saving station there. It is said to be unsinkable and is designed for rescues at sea beyond those possible with smaller man-powered lifeboats.

The length of the vessel is sixty-one feet and its beam fifteen feet. Even in high seas, it can carry 150 people safely, its makers declare. The cost of construction was $70,000. This sum was supplied by a well-known steamship line of England interested in perfecting more efficient equipment for shore life-saving stations.

Alaska's Million Reindeer Form Great Industry

ONE MILLION reindeer are now living in Alaska, according to a recent Government estimate. Known as "the camels of the frozen North," they are said to have greater value as beasts of burden for long-distance travel than the husky dog, and to be able to outdistance horses on a short stretch.

Besides its value as a transport animal, the reindeer is a principal source of food and clothing for the Eskimos of Alaska. Within the last twenty years, the reindeer industry there has become second in importance to the fishing industry. More than 2,000,000 pounds of reindeer meat was exported from Alaska last year, much of it to meet a growing demand in the United States.

Forty years ago, there were no reindeer in Alaska. At that time, because of a growing scarcity of seals, whales and walrus upon which the natives depended for food and clothing, Dr. Sheldon Jackson, U.S. General Agent of Education in Alaska, proposed bringing a herd of the animals from Siberia. In 1891, with funds subscribed by private citizens, he bought 171 reindeer, and for nine succeeding years the U. S. Congress appropriated sums to add to the Alaskan herds and to train natives in caring for them.

Onions Their Own Doctors

THE red and yellow onion make their own antitoxin to kill parasitic fungi that try to live at their expense. The less fortunate white onion, however, falls a prey to the fungus. A recent laboratory analysis by chemists of the University of Wisconsin showed that the red and yellow varieties contain an acid belonging to the phenol series which stops the growth of the parasitic plants.

Invents Movie Film Made of Canvas or Paper

A CANVAS belt becomes a movie film through the magic of a new process recently announced by a Pittsburgh, Pa. experimenter, Dr. Fred W. Hochstetter, who is pictured above with a strip of his new film. The invention is said to permit the use of paper as well as silk, linen, and cotton cloth as a base for movie and talkie films.

According to the inventor, the cloth or paper strips may be washed and ironed without injury, and they are said to be nonflammable. In place of the usual emulsion, used on ordinary movie and photographic films, Dr. Hochstetter explains he uses a mixture having a selenium base.

In projecting images on the screen from the canvas film, it is pointed out, light does not pass through the film, but is reflected from its surface. Dr. Hochstetter also announces that he has perfected a projecting machine for talking movies recorded on his cloth or paper films.

Stamps Raise Museum Fund

A SERIES of postage stamps, having currency for a single day, and none intended to be put on letters, were recently issued in the island of Madeira. The purpose of issuing the special stamp was to raise money to build a national museum. Their rarity is expected to make them valuable in the eyes of stamp collectors and thus bring extra revenue to the island government.

Smelter Raises Crops to Test Effect of Fumes

RAISING marigolds and mignonettes, beets and beans, usually does not come within the province of a big industrial concern, but a copper company whose smelting and refining plant is located in the Borough of Queens, New York City, has gone in for truck farming and flower gardening.

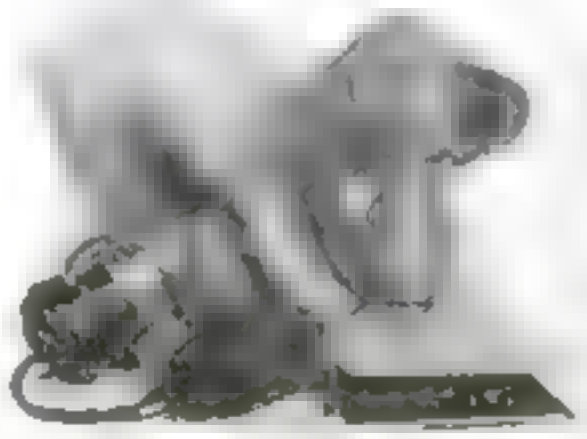
Thus the concern has done as a practical refutation of numerous charges from owners of vegetable and flower gardens in the neighborhood that the fumes from the copper plant kill vegetation for miles around. And the company has not done the thing by halves. Amid its factory buildings it has laid out a real truck farm, where tomatoes, radishes, peppers, onions, cucumbers, pumpkins, eggplants, lima beans, corn, and other vegetables, as well as many varieties of flowers, are being raised successfully.

The large variety was decided upon to prove that all manner of plants are able to withstand the factory fumes. Officials of the company emphasize the fact that the ordinary methods of fertilization and cultivation have been followed in the experiment.

This Little Reading Lamp Clamps to Your Book

A TINY reading lamp that clips onto your book, magazine, or newspaper and provides illumination for the page is the latest innovation in lighting comfort. An adjustable shade, covering the little bulb, can be tilted to direct the light out of the reader's eyes and onto the printed matter.

Because the midget lamp is extremely light, and its extra wide clip holds it firmly attached to the paper, its presence is said to be hardly noticed by the reader.



The midget reading lamp, showing wide spring clamp that fastens it to book or magazine.

Huge Dry Dock Sections Go on Ocean Voyage

MOVING like huge buildings across the water of Lower New York Bay, five sections of two dry docks recently began a trip down the Atlantic Coast to the Gulf of Mexico. Harnessed to them with heavy cables, five powerful tugs puffed and strained, dragging the unwieldy structures into the open sea.

The sections, one of which appears in the photograph, have a combined lifting capacity of 10,000 tons. Two of them went to New Orleans, La., and three were added to a floating dry dock at Mobile, Ala. These additions increased the size of the Mobile dock so that now it is eighty-eight feet wide and nearly as long as two city blocks.

With the enlarged capacity of the two southern docks, the owners, the Todd Shipyards Corporation, of New York City, will have facilities for dry-docking 175,000 tons of shipping at one time.

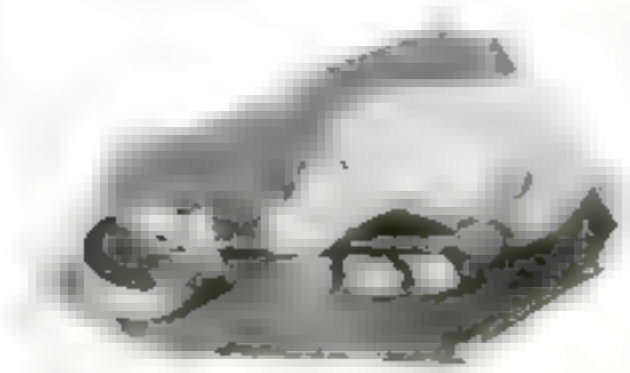
Voyagers Send Greetings by Phonograph Records

THE first word-of mouth messages from ocean voyagers to the folks back home were dispatched from the French liner *Ile de France* by means of phonograph records dictated by outbound passengers. The records, which are seven inches in diameter, will run for two minutes and record about 300 words. They may be played on any home talking machine and are said to be indestructible. Special containers for mailing the records are provided.

Novel Pencil Sharpener Guards the Points

A HANDY pencil sharpener for desk use, pictured below, is designed to prevent breaking the point by pulling the pencil out of line while turning it. The sharpener is swiveled so it can move up or down or to either side to accommodate the pencil if jerked out of line.

A little metal cup, to which the sharpener is attached, catches the shavings so they are not scattered about. In using the device, the sharpener is held with one hand while the pencil to be sharpened is turned with the other.



New desk pencil sharpener with swivel arrangement to prevent pencil point from breaking.

Automatic Photographer Lets You Pose Yourself

WHEN you go to the photographer's in the future you may choose your own pose and see what your portrait will look like when finished, if a new invention by Luther G. Simjian, director of photography in the Yale School of Medicine, New Haven, Conn., is universally adopted. The inventor, shown above with a model of his device, says that it eliminates the necessity of making many exposures from which the subject chooses one or two poses, as at present.

The invention, the result of five years experiment, consists of a booth in which the subject sits facing seven mirrors, so that he sees his features reflected from seven angles. No operator is necessary. When a choice of the most satisfactory pose has been made, the subject presses a button and an invisible camera records the picture from the angle of the mirror in which the chosen reflection appears.

As soon as the picture has been taken, the lights in the booth go out, the film in the camera is changed automatically, the lights flash on again, and the apparatus is ready to take another picture. Because the subject is alone when the photograph is made, Simjian says, natural facial expressions, without traces of self-consciousness will be recorded.

Science Preserving Rare Vatican Manuscripts

TO PREVENT the corrosion or cracking of priceless manuscripts in the Vatican at Rome, two types of machines for conditioning the air have been built by the General Electric Company.

In the damp summer months the atmosphere in the Vatican library becomes so humid that the books show a tendency to decay. This problem was solved by installing seven electric air drying units. In winter, on the other hand, the air is so dry that the manuscripts become brittle and are likely to crack or break. To remedy this condition a moisture-creating device was designed, consisting of a tank filled with water in which a series of electric heating elements are immersed. Humidity gages and thermostats keep the water at the correct temperature to discharge the desired amount of water vapor into the rooms.

Finds Rats Are Guided by Hearing, Not Reason

THE theory that animals think and reason like human beings received a setback recently when experiments directed by Dr John F Shepard, professor of psychology in the University of Michigan, revealed that they depend more upon their sense of hearing than upon sight, smell, touch, or any reasoning power. In laboratory tests to discover how rats find their way rapidly out of a maze he found that soundproof material placed on the floor caused the animals to wander aimlessly among the complicated passages, although they previously had been able to reach the one exit with ease.

The experiments, Dr Shepard reported, indicated that the rats were guided, not by reason, but by the sound of their feet and the echoes which varied as they scurried toward the exit. Further studies are being conducted to discover whether rats depend entirely upon their sense of hearing to find their way.

How to Build Our Screen Grid Distance Getter

Tests Prove This New Radio Receiver Is Ten Times as Sensitive as the Average High-Grade Instrument

By ALFRED P. LANE

HERE is a radio receiver designed especially to reach out and bring in the stations. It is the most sensitive circuit ever tested in the Popular Science Institute of Standards radio laboratory.

According to the modern standardized methods of testing the sensitivity of a radio receiver, the new POPULAR SCIENCE Screen Grid Distance Getter, when coupled to the usual two-stage audio amplifier, will produce a standard loudspeaker signal when the strength of the broadcasting is less than one microvolt per meter on any wave in the broadcast band. The set described here is almost ten times as sensitive as the average really high grade radio receiver.

The selectivity of the POPULAR SCIENCE Distance Getter is on a par with the finest sets available

If bringing in distant stations appeals to you or you are located where you must depend on distant stations for your radio entertainment and you like to do radio construction work, this receiver will appeal to you both because of its unusual results and because the construction work is relatively easy. Furthermore, there are absolutely no adjustments to make. If the shielding and wiring are carried out according to instructions the receiver is bound to work right. You do not have to make balancing adjustments of any kind.

The tuning of the new receiver is, of course, more tedious than with the usual single dial control outfit, but on the other hand the individual dial construction is much simpler and there is no chance for reduced efficiency owing to lack of synchronization between the stages, as may be the case when you use a single control

OF COURSE, if you wish to go to the extra trouble of constructing this receiver as a single control job all you need do is to separate the shields so as to allow space at the center for the necessary drum dial. The condensers are, of course, turned so that their shafts are parallel to the panel. If you do this it will be necessary to use midget condensers in parallel with *C1* and *C4*, as these two stages do not tune exactly like the second and third stages controlled by condensers *C2* and *C3*

The new POPULAR SCIENCE Screen Grid Distance Getter uses three of the latest UY 224 A. C. type screen grid tubes and one 227 A. C. type heater detector tube. The circuit therefore, comprises three stages of screen grid radio frequency amplification with a tuned detector circuit. The unit is designed to be used with any standard type of power amplifier or the ordinary two-stage audio amplifier

The detector tube is connected in what is known as the plate rectification or power detector circuit, there being no grid condenser and no grid leak, instead a dry cell C-battery is used. One advantage of this arrangement is that you can eliminate the first audio stage and feed the detector output directly into the power amplifier stage. The radio-frequency amplification is so great that under normal conditions you will get plenty of signals from the loudspeaker with only one audio amplifier stage. Another advantage of power detection is that hum troubles are greatly reduced. The amount of hum you receive from the loudspeaker depends largely on the amount of audio amplification in the circuit and not on the number of radio-frequency stages.

POPULAR SCIENCE MONTHLY Blueprint No. 109 describes in great detail the construction of the POPULAR SCIENCE Screen Grid Distance Getter (see page 115). It includes a complete picture wiring diagram of the receiver with audio amplifier and all accessories.

A complete list of parts approved by the Popular Science Institute of Standards will be sent with each blueprint or will be mailed without charge to readers who do not wish the blueprint. Address requests for information to Technical Editor, POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York City.

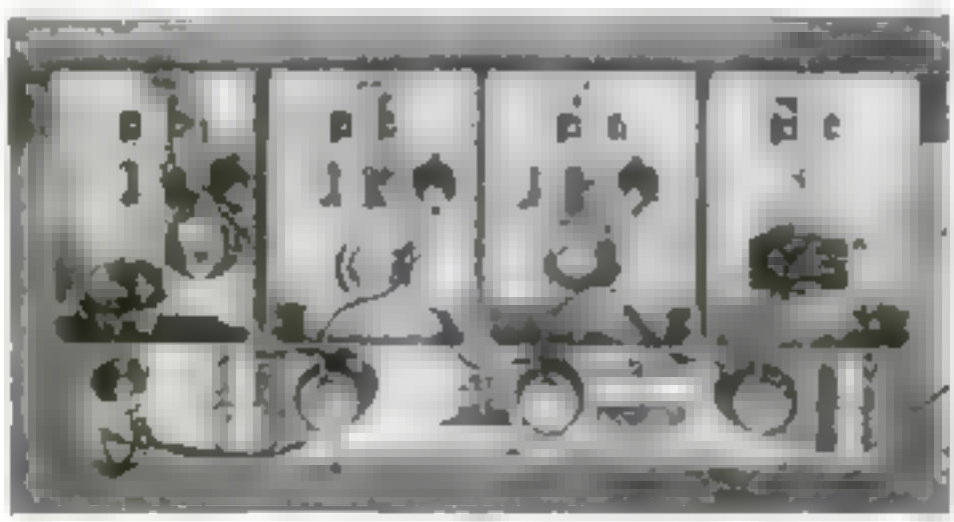


Fig. 1. This top view of the receiver will help you lay out the parts. Eye measurement is ample. Note that the aluminum stage shields are spaced.

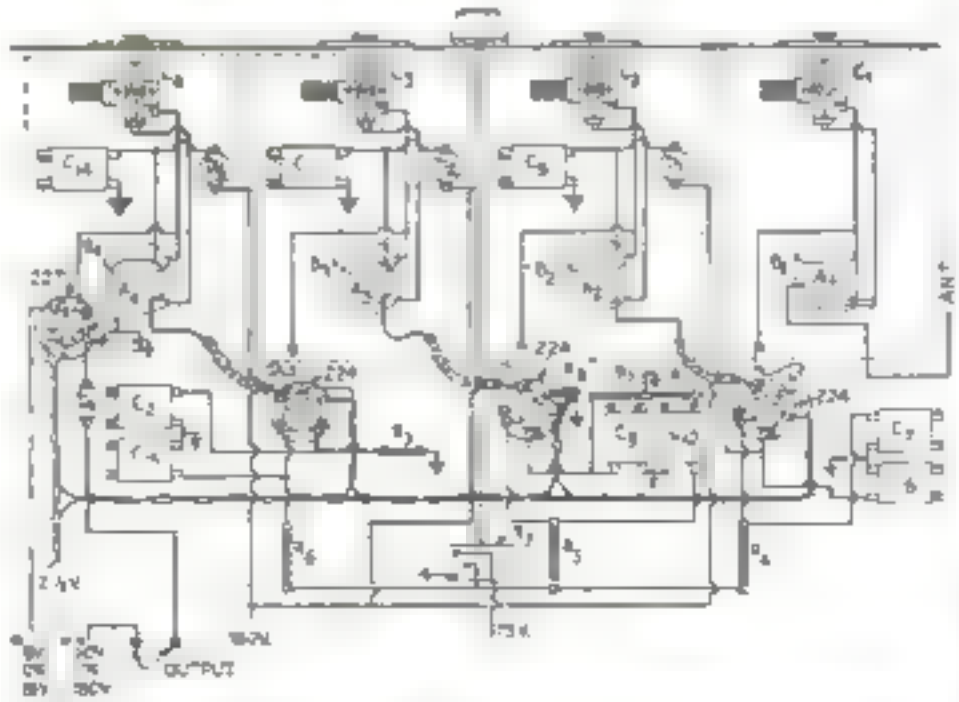


Fig. 2. Pictorial wiring diagram. Parts on and under sub-base are spread out, and R.F. transformers tipped out of position, to make wiring clearer.

FIGURE 7 shows a typical audio amplifier circuit for use with this receiver, though of course you can use any other standard audio amplifier circuit. The dotted line in this figure indicates where to cut out the first audio stage if you do not wish to use it. If space is an important requirement you can mount the single audio stage in the space just back of the fourth shield, which houses condenser *C4* and coil unit *A4*, *B4*. We recommend,

however, that the audio amplifier stage be built into the power unit, or as a separate unit if you use a factory built B-eliminator.

Many of our readers are located where no electric light current is available and so we include a diagram, Figure 5, which details the POPULAR SCIENCE Screen Grid Distance Getter arranged for use with the UX-222 battery-operated screen grid tube. In the battery operated circuit parts *R1*, *R2* and *R3*, *C6*, *C9* and *C12* are eliminated, and parts *X1*, *X2*, *X3*, *X4*, *X5*, and *X6* are used instead. Each one of these parts is a fixed 10-ohm resistance. Also, because the UX-222 is not as efficient a radio-frequency amplifier as the UY-224, it is desirable, in the battery operated circuit, to use the grid condenser and grid leak. Consequently parts are indicated at *L*. Use a two-megohm grid leak and a .00025 grid condenser. Part *Y* should be a standard self adjusting rheostat designed for use with a battery type 201A tube.

In battery operated form the receiver is not as efficient, or, in other words, not as sensitive to distant stations, as it is when constructed for full electric operation, but the battery operated Distance Getter will out perform by a large margin any standard type of battery receiver.

Here are the parts you will need to build the POPULAR SCIENCE Screen Grid Distance Getter in full electric form, using UY-224 tubes as radio-frequency amplifiers and the UY-227 tube as a power detector:

A1, *B1*—First-stage tuning unit

A2, *B2*; *A3*, *B3*, *A4*, *B4*—Screen grid type radio-frequency transformers

C1, *C2*, *C3*, *C4*—Variable condensers, .00035 mfd. capacity

C5—Fixed condenser, .0005 mfd. capacity

C6, *C7*, *C8*, *C9*, *C10*, *C11*, *C12*, *C13*, *C14*—.25-mfd. fixed condensers

D1, *D2*, *D3*, *D4*—Radio-frequency choke coils, 85 millihenry inductance

R1, *R2*, *R3*—Fixed resistances, 1,000 ohms

R4, *R5*, *R6*—Fixed resistances, 5,000 ohms

R7—10,000-ohm potentiometer

R8—10- or 20-ohm center tap fixed resistance, or 10- to 20-ohm potentiometer

Four aluminum shields—size 6 by 8 by 5½ inches

Four Y-type sockets

Three shielded grid tube shields

Three shielded wire connectors

Four dials

One 7 by 28-inch panel

One baseboard, 14 by 27 inches

Each part listed is a standard factory-built article which can be obtained from any dealer. However, the arrangement of the circuit and the layout of the parts allow plenty of space for you to use parts you have on hand. The coil specifications are:

A1, 2¾ inches diameter, 15 turns No. 24 wire, tapped at the 4th and 8th turns

B1, 3 inches diameter, 60 turns No. 22 wire

A2, *A3*, and *A4*, each 1¾ inches in diameter with 100 turns of No. 36 wire spaced 117 turns per inch, tapped at 60th and 75th turns (We find 75 turns give best results in this circuit.)

B2, *B3*, and *B4*, each 2 inches in diameter with 86 turns of No. 30 wire spaced 30 turns per inch

If you are unable to space-wind your coils you can, of course, wind them close, using fewer turns in each case. However, space-winding adds to the efficiency. As the coils are not expensive, if you cannot wind them to these exact specifications it is worth while to purchase the factory-wound coils.

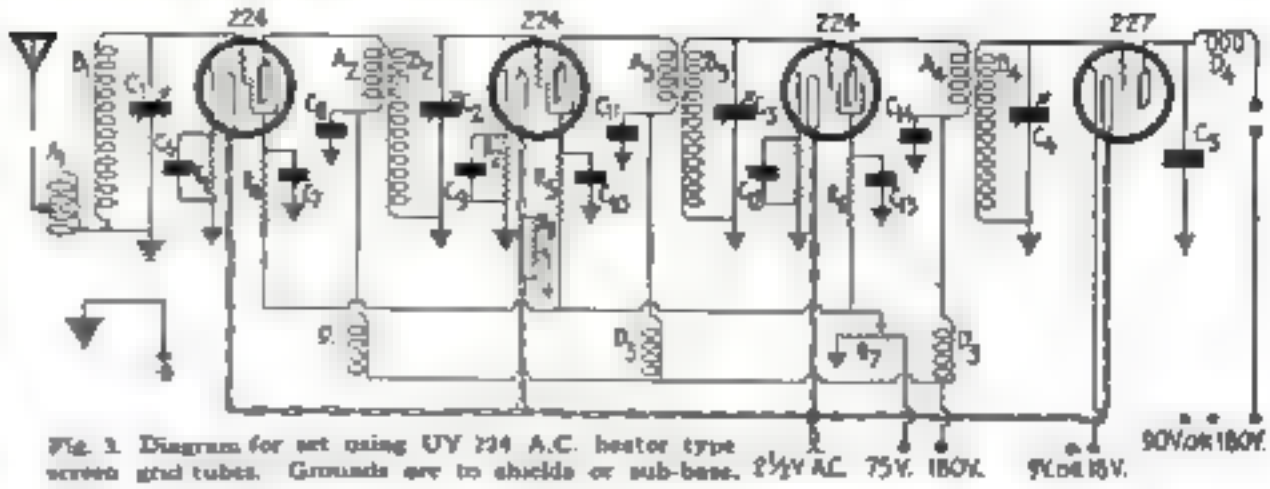


Fig. 3. Diagram for set using UY 224 A.C. heater type screen grid tubes. Grounds are to shields or sub-base. 2½V A.C. 75V. 180V. 90V. OR 135V.

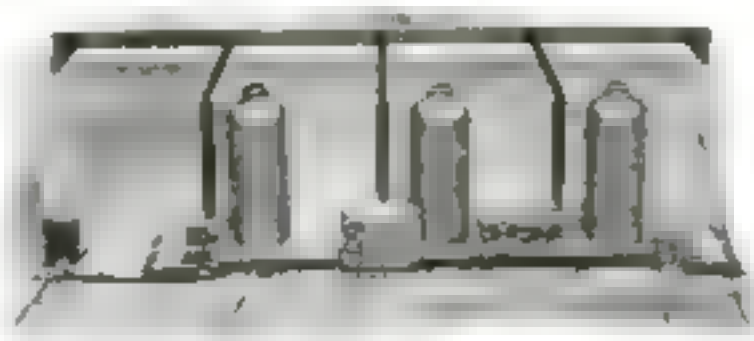


Fig. 4. Each R F transformer with the condenser that tunes it, is in a separate shield. Individual tube shields also are used.

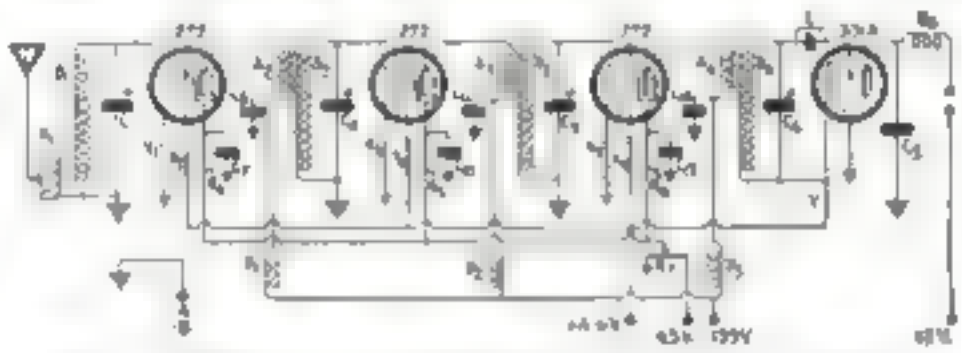


Fig. 5. Use this wiring diagram if you must build the set for battery operation with UX 222 screen grid tubes. Note carefully substitution of parts.

Assembling the Receiver

THE first job is to make the baseboard, either of a solid piece of wood or of layers of plywood to obtain the necessary thickness. Then mount the panel on the baseboard. Take it off and lay out the holes on the panel for the screws and shafts of the variable condensers. After you are satisfied that the condensers are properly mounted on the panel, remove them and fit the front section of each of the four shields in the proper position. Then, using the holes already drilled in the panel as a jig, drill straight through the shields behind the panel. Then remount the condensers and dials (of course you can use any dials you prefer), and proceed to mount the tuning unit *A1*, *A2*, *B2*, and so on, and the condensers and radio-frequency choke coils *C8*, *C11*, *C14*, *D1*, *D2*, and *D3* in approximately the positions shown in the top view of Figure 1.

NOTE that the only reason for the extension shaft operation of potentiometer *R7* is to reduce the width of the panel. If you prefer to use a wider panel, *R7* can be mounted directly on the panel in

(Continued on page 139)

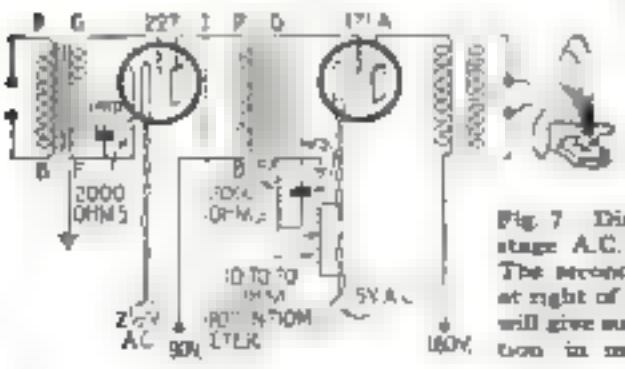


Fig. 7. Diagram for two-stage A.C. audio amplifier. The second or power stage, at right of dotted line alone will give sufficient amplification in majority of cases.

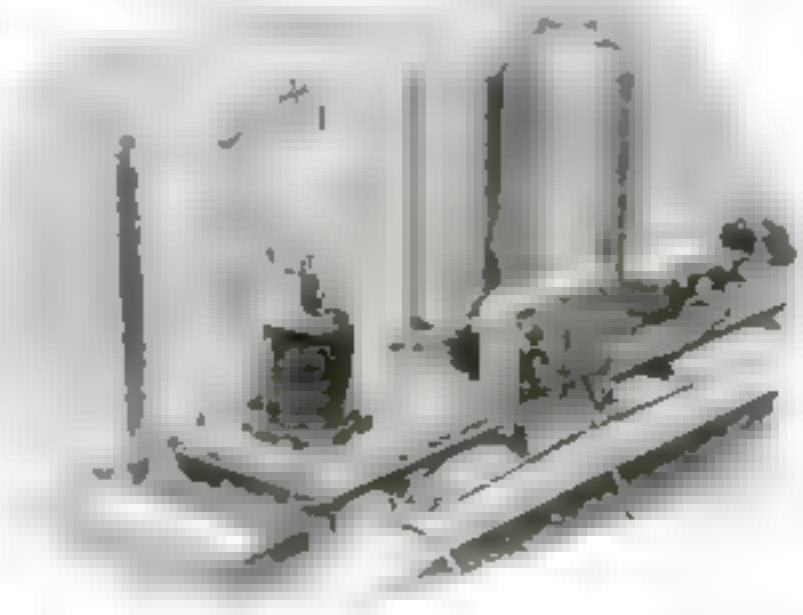


Fig. 6. How screen grid tube sockets are mounted on the sub-base. All socket leads except the plate lead are passed through large holes in the sub-base. With caps of tube shields replaced with wire netting, these holes provide the necessary ventilation.

Useful Hints for Radio Fans

How to Make Your Drills Behave

A Neat Job Is Easy When You Know the Trick—Caring for Your Battery —Simple Ways to Test Radio Parts

IN RADIO construction, as in most other home workshop jobs, much drilling has to be done. Drilling a hole through a piece of metal, bakelite, or wood is simple if you go at it in the right way, so that the drill bites in, cuts easily, and makes a clean, accurately sized hole.

Your hand drill, therefore, is one of the most important tools you own, and, if you can afford a complete set of twist drills ranging in size from No. 1 to No. 60, it certainly pays. Twist drills, as they come from the manufacturers, are accurately sharpened for use on iron and soft steel and they can, of course, be used without any alteration on almost any other material. However, you will get much better results in drilling brass, bakelite, copper, and other soft materials if you will carefully stone the lip of the drill so that the face of the cutting edge is parallel to the axis of the drill. A drill stoned in this way will cut just as rapidly through bakelite, for instance, and will have no tendency to dig in and stick. The same applies with brass and copper.

Possibly you have noticed that sometimes a drill produces a hole larger than itself. This is almost always due to the drill being ground so that one lip is slightly longer than the other. So, when you sharpen your drills, be careful to have both cutting edges of exactly the same length, with the point exactly central on the drill. When you desire to drill a hole exactly to size always drill first with a smaller drill and then use the drill of the size you want as a following operation. Used in this way, the drill acts more as a reamer, and even if not quite true will cut a hole of accurate size.

It is important to have on your work bench a drill pad like the one illustrated here. This should consist of a hardwood board on which the work to be drilled can be placed. Hardwood is preferable because it will help to prevent the drill breaking through suddenly as it goes through the back surface of the works. The drill pad will prevent filling your workbench with small holes, and you can use the holes as sockets for nails or pegs placed around the work to keep it from turning, as shown in the illustration.

A drill pad of hardwood under work protects bench and keeps drill from breaking through.

Test Each Part First

TRYING to locate errors in wiring in a home-built radio receiver after the job is complete is difficult enough without making things worse by including defective parts in the assembly.

Of course, all manufacturers test the parts they make before they are packed for shipment, but sometimes inspectors get careless. Consequently it pays to make sure that each part you use in building a receiver is in good working order before you place it in the circuit.

A high grade voltmeter and a C battery of four and a half volts will prove useful in testing the condition of the parts. For instance, you can determine whether a small fixed condenser is short-circuited by connecting it in series with the battery and the voltmeter. If the voltmeter shows no reading the condenser is in good shape. Likewise you can test every tuning coil by connecting it in series with the battery and the voltmeter. If the voltmeter shows no reading the coil is defective, and if it shows full voltage the wiring is continuous without break.

Audio transformers can be tested in the same manner, first the primary winding and then the secondary winding. The primary winding is connected between the terminals marked P and B, the secondary winding being connected between the terminals marked G and P. The voltmeter should read less than the full four and a half volts on both windings and the reading should be lower on the secondary winding than on the primary winding. The falling off in voltage, of course, depends on the internal resistance of the voltmeter; the cheaper the voltmeter the greater the difference you will note.

RADIO-FREQUENCY choke coils, and the various fixed and adjustable resistances you use in the circuit, can be tested in the same manner. The testing of resistances is of particular importance because a defective resistance causes very peculiar results in the circuit. You will find that an ordinary good eight-volt meter connected in series with a four-and-a-half-volt battery will show some reading on resistances up to ten or fifteen thousand ohms. If you are testing fixed resistances of several different values make sure that the higher resistances show a lower reading on the voltmeter than the lower resistances. Of course the absence of any reading at all indicates that the resistance has an open circuit somewhere and should be discarded.

A B C's of Radio

RADIO waves can be specified either in wave lengths or in frequency. The wave length is the distance from the crest of one wave to the crest of the next. The frequency in kilocycles gives the number of waves that pass a given point in one second. Since the speed of all radio waves is that of light, the two methods of measurement are interlocking. A 200-meter wave must necessarily be one of 1,500-kilocycle frequency. If the radio wave is specified in wave lengths you can find the frequency in kilocycles by dividing 300,000 by the specified wave length. If the wave is specified in kilocycles, divide 300,000 by the frequency, and the result will be the wave length in meters.

Keep the Battery Clean

A RADIO storage battery is not exactly a parlor ornament, but that's no reason for stowing it away in some out-of-the-way corner where it is hard to get at. Conceal it if you wish, but place it where you can get at it easily to add water and to keep the top clean.

Whenever green and white corrosion appears around the terminals of the battery, it should be removed with a rag dipped in ammonia. The top of the battery should be kept clean and dry at all times. If the deposit is allowed to collect it produces surface leakage which results in running down the battery.

How to Pep Up Your Battery Set

Easy Ways to Get the Best Possible Reception Where No Electric Light Current Is Available

By JOHN CARR

THE modern completely electrified radio receiver is the latest thing in radio, but if you happen to live where no electric light current is available, such a set is useless. There is no reason, though, why you cannot get adequate reception with a battery-operated receiver at very reasonable expense.

Your problems are not like those of the owner of a full electric set. To begin with, the fact that you have no electric light current probably means that you are a considerable distance from the nearest broadcasting station. Your problem is to get distance, and the matter of selectivity is of relatively little importance.

For distance, put up a high and long outdoor antenna. This is especially important if your receiver is battery operated, because the high and long antenna will make up for lack of receiver sensitiveness and you can use a set having fewer tubes for the same all-around results as could be obtained with a shorter antenna and a multitube set. As you are not surrounded by broadcasting stations there is no need for the highest degree of selectivity.

Few manufacturers now make battery-operated radio receivers, but of course there are hundreds of thousands of secondhand receivers available from dealers who have traded in these sets as part payment on more modern electric receivers. If you do not wish to purchase a complete factory built receiver it is entirely practical to assemble for yourself a battery operated set that will give excellent results. POPULAR SCIENCE MONTHLY Blueprint No. 45 shows in detail how to construct a four-tube set that is exceptionally easy to build, economical of battery power, and gives maximum results for the number of tubes involved.

Blueprints 54 and 55 describe a five-tube set that is somewhat more sensitive and selective, and is designed for use with the power tube. This receiver is exceptionally economical of battery current considering the number of tubes used.

THE type of set that will best answer your requirements depends on the use you expect to make of it and the power available. If no power service is available and you are so far from the nearest service station that having a storage A-battery charged at intervals becomes a real burden, then it would be desirable to purchase or build a set that will operate entirely on dry cells. Our Blueprint 43 covers this point. Obviously if you must use dry cells, it is most desirable to have the set extremely economical of battery current. This means that you should use as few tubes as will give adequate results. The most economical type of dry cell tube is the 199, with the 120 in the last stage.

Testing. In the Popular Science Institute radio laboratory, the power output of 112A battery-type tubes in push-pull.

IT IS well to remember in this connection that while three No. 6 dry cells connected in series will operate a filament circuit for 199 and 120 tubes, it is much more economical to use as many as nine cells connected in a series-parallel arrangement. This practically means three separate sets, of three cells each, connected to the receiver at the same time. Cutting down the drain on each individual battery in this way prolongs the life to more than the total number of hours of service that could be obtained from the sets of cells if used one set at a time.

For economy in B-battery current consumption, you should use C-battery voltages on the radio-frequency amplifier stage, first audio stage, and power stage. Run the C-battery voltages to as high a point as you can and still obtain adequate reception, because every increase in C-battery voltage results in a decrease in the current drawn from the B-battery.

Many radio fans are located where the only current available is from a thirty-two-volt farm lighting plant. If this is close at hand your current problem is solved by tapping three cells of the farm lighting battery. But if your receiver is located at a distance from the farm lighting plant this plan is not so satisfactory because of the loss in voltage in the wires running from the receiver to the battery. With such an arrangement it is desirable to use a special rheostat which will cut down the thirty-two volts from the nearest socket so that you can use it directly on the filament circuit of the set. It is absolutely necessary with a current supply arrangement of this type to use a high-grade voltmeter that tells you what voltage you are applying to the tubes, otherwise you are likely to burn them out.

IF THE set is of the average five-tube variety the rheostat should have a current-carrying capacity of two amperes and a total resistance of thirty ohms. The voltmeter should read to a maximum of six or eight volts, and the simplest method is to turn the rheostats on the set all the way on and then turn the main control rheostat slowly from the "no current" position until the voltmeter reads exactly five volts. Always turn off the current with the main rheostat, so that a change in the condition of charge of the farm lighting battery will not put excess voltage on the tubes. Special large rheostats of the rating specified can be purchased from any radio supply house.

If your farm lighting plant is of the 110-volt variety you can use the same system for operating the filament circuit except, of course, that the rheostat should have a resistance of ninety ohms instead of thirty ohms. In addition, you can obtain your B-current from the farm lighting circuit simply by using a filter circuit to cut out the hum. Even this is not necessary if your farm lighting plant has a large battery so that the generator need not be run at the time when the radio receiver is being used.

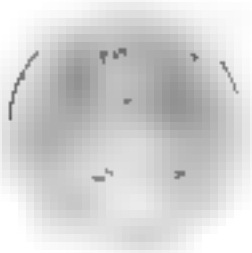
YOU will, of course, have to be satisfied with lower volume output from a battery-operated set than can be obtained from a modern full electric set, unless you wish to go to considerable extra expense for dry cell B-batteries. The maximum volume with the minimum current drain can be obtained by using 112A-type tubes in push-pull in the last stage. Two tubes of this type in push-pull will give about the same power output as a 171A at less current drain on the B-battery; although, of course, the current drain on the A-battery is twice that of the single 171A.

How to Choose a Heating Plant

A Typical Home Builder Learns from an Expert the Merits of Warm Air, Hot Water, Steam, and Vapor-Vacuum Systems

By

ROGER B. WHITMAN



WHEN Bob Kersey set out to decide on how to heat his new house, all he knew about heating was to turn on the radiator when the room was cold, and to telephone the janitor if nothing happened. Aware of his ignorance of the subject and impressed by his architect with its importance, he adopted a program of self-education. He had the names of several makers of heating systems, and with the plans for his house in his pocket he began a round of visits to their salesrooms. The first call showed him how little he knew.

"I'm building a house and want a heating plant for it," Bob said to the salesman. "What do you recommend?"

"What have you in mind? Warm air, hot water, steam, or vapor-vacuum? We make them all."

"To tell the truth," Bob said, "I don't know. It's all Greek to me. But I want to learn, and I'd like it if you can spare the time to explain things."

"I'll be glad to; let's sit down. Your problem is to keep the house warm in cold weather. What you do is not to heat the house, but to heat the air in it. You have a fire burning in the cellar, and the difference in heating systems is in the way they get the heat of that fire upstairs. A warm air system brings the air down to the heater for warming, and lets it go upstairs again. Steam or hot water systems take the heat upstairs to the air. One method uses water and the other doesn't, and as far as warmth is concerned, you'll be comfortable with either."

"BUT why different kinds? One must be better than the other, and if that's so, why doesn't everybody use it?"

"Well—price has something to do with it, and so has personal opinion. Some of our customers think that warm air is the finest, and others wouldn't have it on a bet. The design and location of a house enter into it, too. A long, rambling house on an exposed hilltop might be more easily heated with radiators than with registers; register heat is ideal for a compact, sheltered house."

"Why won't register heat do for them both?"

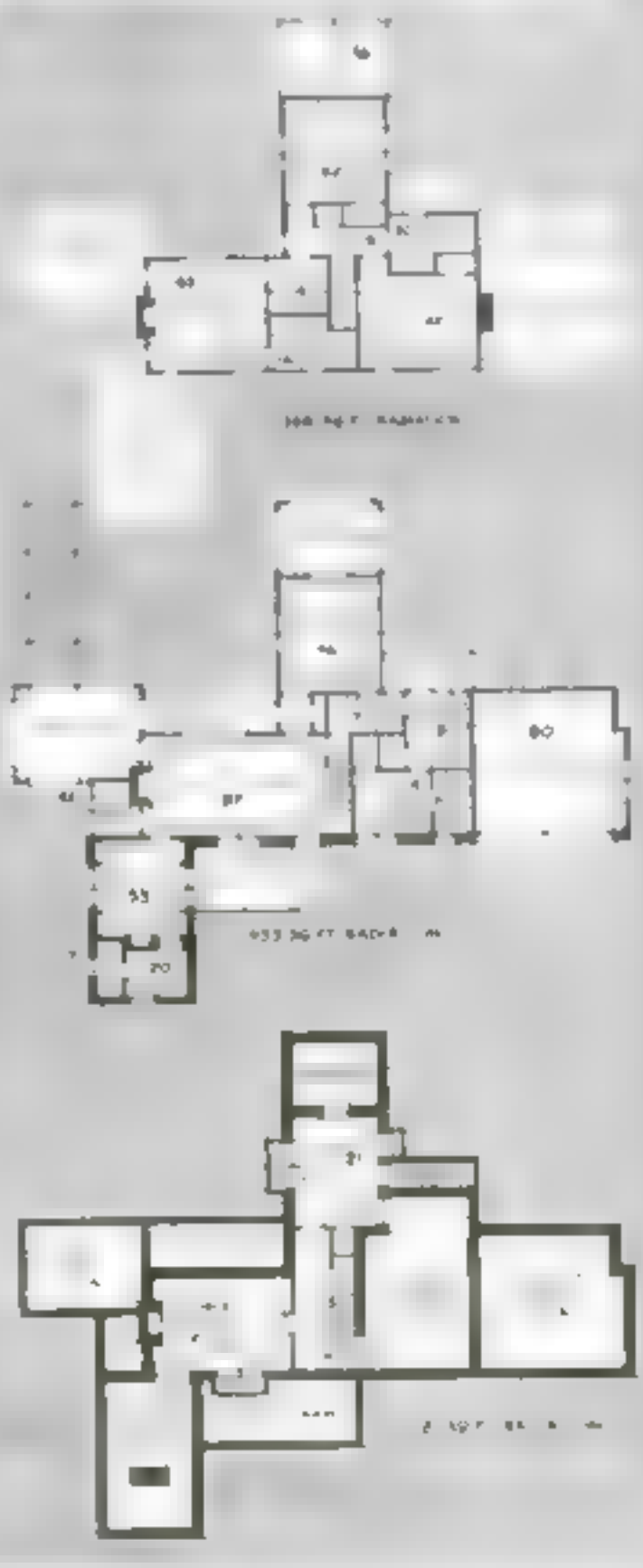
"UNDER proper conditions it will; but you see, while warm air will rise, it hasn't much power, and if it has far to go in horizontal pipes it may cool off and quit. But before you ask more questions I'd better tell you how the different systems work. A warm air heater is a stove with a jacket around it. As the air in the jacket is warmed, it expands and consequently rises. Pipes from the top of the jacket lead it to the rooms that are to be heated, and cool air comes into the jacket at the bottom to take its place. When a current of warm air enters a room it pushes out the air already there, but that air is cooler and heavier, so it sinks and goes out along the floor. It flows to the ground floor from upstairs like so much water, and finds its way to a channel that leads it back to the jacket to be heated over again. That gives a general circulation of air all over the house, for it is either rising from the jacket when warm, or sinking back to it as it cools off. The only objection to that system may be that on windy days the exposed rooms won't get as much warm air as the sheltered ones. Modern systems correct that by having two pipes to each room, one to a register high on the wall for warm air and the other from a register at the floor to carry the cool air back to the heater. That gives more even heating than the old way, and to make it still surer the warm air is blown to the registers by an electric fan in the intake of the jacket."

"THEN that system uses the same air over and over again. Is that healthful?"

"Yes, because stale air leaks out through the roof and other places, and fresh air comes in at the windows and doors. There are mighty few houses so tightly

IF YOU, like the Kerseys, are planning to build a home of your own, the Popular Science Institute will be glad to aid you in selecting the right materials and equipment.

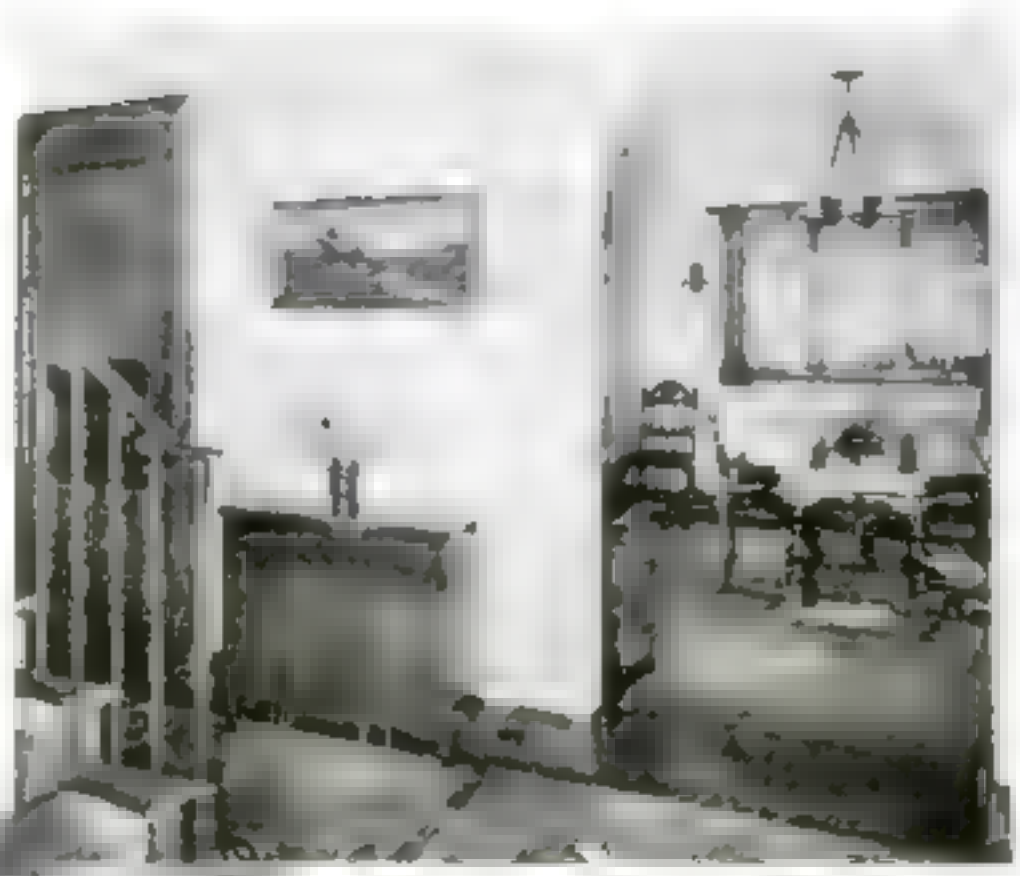
Just write to the Building Service, Popular Science Institute, 381 Fourth Avenue, New York City.



Courtesy The Home Guild of America, Architects

Cellar and upper floor plans of the house the Kerseys expect to build, showing radiation figures for each room. Total radiation is 722 square feet, for which the expert recommends a 1,600-foot boiler

built that plenty of air for ventilation won't leak. The other day I saw some tests that showed that with a light wind, there would be enough leakage through the joints of a well fitted window to change the air in a room of ordinary size once an hour. There will be plenty of air coming in; you'll worry more about keeping it out. Old-fashioned systems took their air from outdoors because builders did not realize that and the fires had to be kept roaring to warm that icy air to a comfortable temperature. You save on fuel in reheating house air, and conditions are just as healthful.



Against wall is an automatic humidifier that replaces a radiator in a steam, vapor vacuum, or hot water system. It supplies moist, warm air continuously.

An up-to-date cellar laundry. The apparatus, from left to right, includes a coal burning hot water supply tank a one pipe steam heater a garbage and waste incinerator an electric washing machine, and an electric ironer

A modern warm air heater with electric fan in intake to blow warm air to registers.

"You don't get a general circulation of air with steam, hot water, or vapor heat, for each radiator is an independent heater. The air around it rises as it is warmed, and its place is taken by colder air from the floor. No matter how exposed a room may be, you'll get heat in it with any of those systems; the pressure in the boiler takes care of that."

"Is there any difference between a steam and a hot water system?"

"THERE surely is. In a steam system the boiler is only partly filled with water, and the radiators are cold until the water boils. Until then the radiators and pipes are filled with air, and to make room for itself the steam that forms has to push it out. You know those nickel-plated things screwed into radiators? Those are the valves where the air escapes, they let out cold air but close up when hot steam tries to go through. When steam gets into a radiator it condenses because the metal absorbs its heat, and if nothing were done about it the radiator would fill with water. That can't happen because as fast as the water forms it runs back to the boiler, sometimes by its own pipe and sometimes by the same pipe that carries the steam. Did you ever hear a banging in a heating pipe? That was steam going one way and fighting water going the other."

"I'll say I have; I lived in an apartment once where the pipes made a terrible racket every morning. I couldn't stand it, and moved out."

"There's no noise with a one-pipe steam system when the pipes are big enough to give the steam and the water room enough to pass. The complaint that people make about steam is that there's no heat when the water is not boiling, and that radiators are either cold or hot. A vapor-vacuum system does away with that; it's like a steam outfit, plus some attachments that keep the air out of the pipes and radiators and create a vacuum in them. The water in the boiler turns into steam at a much lower temperature because of this vacuum, and there's a continuous gentle heat at water temperatures where there would be no heat at all with the ordinary steam system. That system is a lot more expensive than steam, but people who have installed this system swear by it.

"Hot water heat is continuous and gentle, too. The whole system is filled with water—boiler, radiators, and all of the pipes. There are two pipes from the boiler to each radiator, and when the fire is going the whole body of water is in circulation; hot water rises to the radiators, cools off, and sinks back to the boiler to be heated over again. It takes quite a while to heat, but on the other hand, it has an advantage in that the radiators stay warm a long time after the fire is shut down.

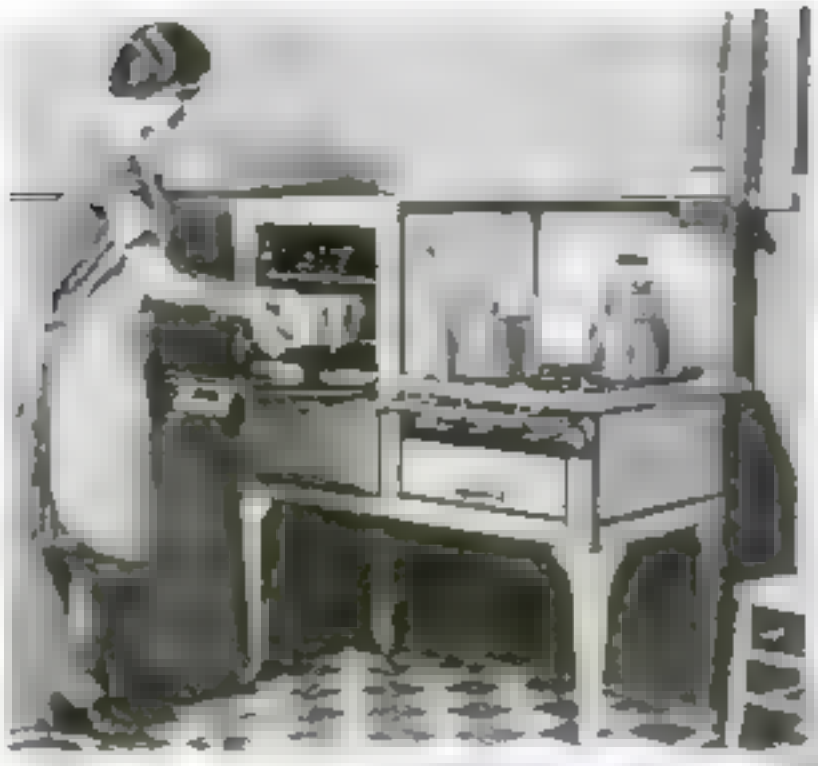
"THERE'S another point for you to think about, by the way; the speed with which you can get the house warm. Hot water is slowest, because of the big body of water that must be heated. Steam is quicker, and vapor-vacuum quicker yet, for the boiler is only partly filled with water and you don't have to wait for it to boil. The quickest is warm air, for you get action about as soon as you start the fire."

"Well, you've taught me a lot of things I never knew before, and I'm certainly obliged to you," said Bob, rising. "I'm going to think them over, and I'd like to come back in a few days, if I may. In the meantime, will you look over these plans for my house and tell me how you'd heat it if it were yours?"

With that understanding he went on his way. In his visits to other showrooms he realized his good fortune in having made his first call on a company making all varieties of heating plants, for he had been given an unbiased view of the whole field. He found a different situation when he visited manufacturers of only one type of heating equipment, for each felt that his had advantages over all of the rest. After listening to their arguments, Bob concluded that whatever he chose, his house would be warm. There would be no great difference in the fuel burned. (Continued on page 197)

Two steam boilers of the same capacity, the one at the left burning coal and the other fired by ordinary illuminating gas from the mains.

One of the problems of serving cold drinks from an ordinary pitcher is that of preventing small chunks of ice from pouring into the glass with the liquid. The pinched lip of this new pitcher holds back the ice when pouring.



Inventions for Household Convenience

This bag of rubberized fabric offers an ingenious way of fumigating or airing garments with a vacuum cleaner. Attaching the blower side of the cleaner causes moth-killing fumes to permeate the garments. Attaching the suction side draws off the fumes and aerates the clothes thoroughly.

This simple device not only punches holes in the tops of milk cans for pouring, but also keeps the holes "corked" when the can is not in use. Clamped to the top of the can, the device consists of two levers, each with a sharp point on its outer end. Pressing the points down punctures the cap. Pressing the inside ends of levers raises the points for pouring.

With the capacity of a dozen eggs, this combination egg beater and pouring pitcher is designed to save time for the housewife in preparing cakes and other desserts. Measuring graduations are marked on the glass.

Uniform slices of bread, cake, or meat can be cut with an ordinary knife inserted between the guides of this aluminum device. An adjustable stop ahead of the guides can be set for any desired thickness

This rubber disk serves either as sink stopper or soap tray. Ridges on its surface make it useful for the latter purpose. The heavy rim holds the soap in place and also prevents the disk from warping.

DOING the Same Old Thing in a Brand-New Way Ideas That Put an End to Drudgery

To the long handle of a rub brush is attached a rubber lever like those used for windows. When the floor is scrubbed, a few sweeps of the drying device gather up the moisture.

An adjustable swinging seat, two drawers, two towel racks and a receptacle for waste are conveniently built between table for preparing vegetables and salads. The photo shows how waste is dropped through an opening in the center of the table top

More biscuits can be baked in an ordinary sized oven with this new baking sheet. As shown in this picture, it will hold exactly two dozen biscuits, enough for a meal for a good sized family. A convenient handle at one end, and the fact that the aluminum sheet is light in weight, enable the housewife to remove it easily from the oven when the biscuits are baked.

A folding stepladder designed for safety first. The working step is three times the usual width, providing a spacious platform on which to stand while hanging curtains or cleaning high walls. An extra step above the platform serves as a brace for the knee, giving additional security.

This kitchen cooler can be adjusted to fit into any window, providing an auxiliary to the household refrigerator. The door swings downward into the room. Screened vents, which allow circulation of outdoor air within the cooler, automatically close every time the door of the box is opened, thus preventing cold air in winter from entering the room.

Only Half a Ship Model *but* —

It's Easy to Construct and a Brilliant Ornament When Hung Up in a Scenic Case

By E. ARMITAGE MCCANN, *Master Mariner*

A scenic half model requires no dusting, takes up little space on the wall, and is not easily damaged.

SO SIMPLE is this picturesque little ship model to build that only a jackknife is required for making everything but the case. The necessary materials are a few scraps of white pine, some sewing thread, putty, and paint

This type of model is called a scenic half-model because only half the hull and sails are used, and these are fastened to a board that is painted to represent the sky and to a base that carries a putty sea.

The example shown is an iron barque, the *Lizzie Nevitt*. I chose her because she was my first command when I was only nineteen. You may, however, take any of the ship model blueprints published in the past by POPULAR SCIENCE MONTHLY (see the list on page 115) and make a half model by applying the principles given here The same applies to size, for while the instructions are for a picture 15 by 22½ in. over-all, you may enlarge or reduce the dimensions to your taste

From the lines given at the right and on page 79 or, better still, the full size lines on our new ship model blueprint No. 108, cut a half hull. This should include the thickness of the whole stem and sternpost and extend about ⅝ in. below the water line to allow for the waves. A piece of white pine ⅞ in. thick by 1 in. deep and 10¼ in. long will be large enough. Draw the profile, including the bulwarks and high ends; cut to these lines, then carve the hull to the body (cross section) lines and carve out the waist to give the main deck level. Leave the bulwarks, poop, and forecastle standing.

Make your deck furnishings: a deck house, one boat on top and another on skids aft, hatches, companionways, capstans, steering gear, and so on. Remember that only half of anything that is on the midship line is required. Set handrails around the forecastle and poop decks, these can be needle eyes with white thread run through. Varnish the decks; paint the bulwarks white and the deck fittings teak (brown) color with white boats. Outside the hull will be a slate gray above the water line and red below

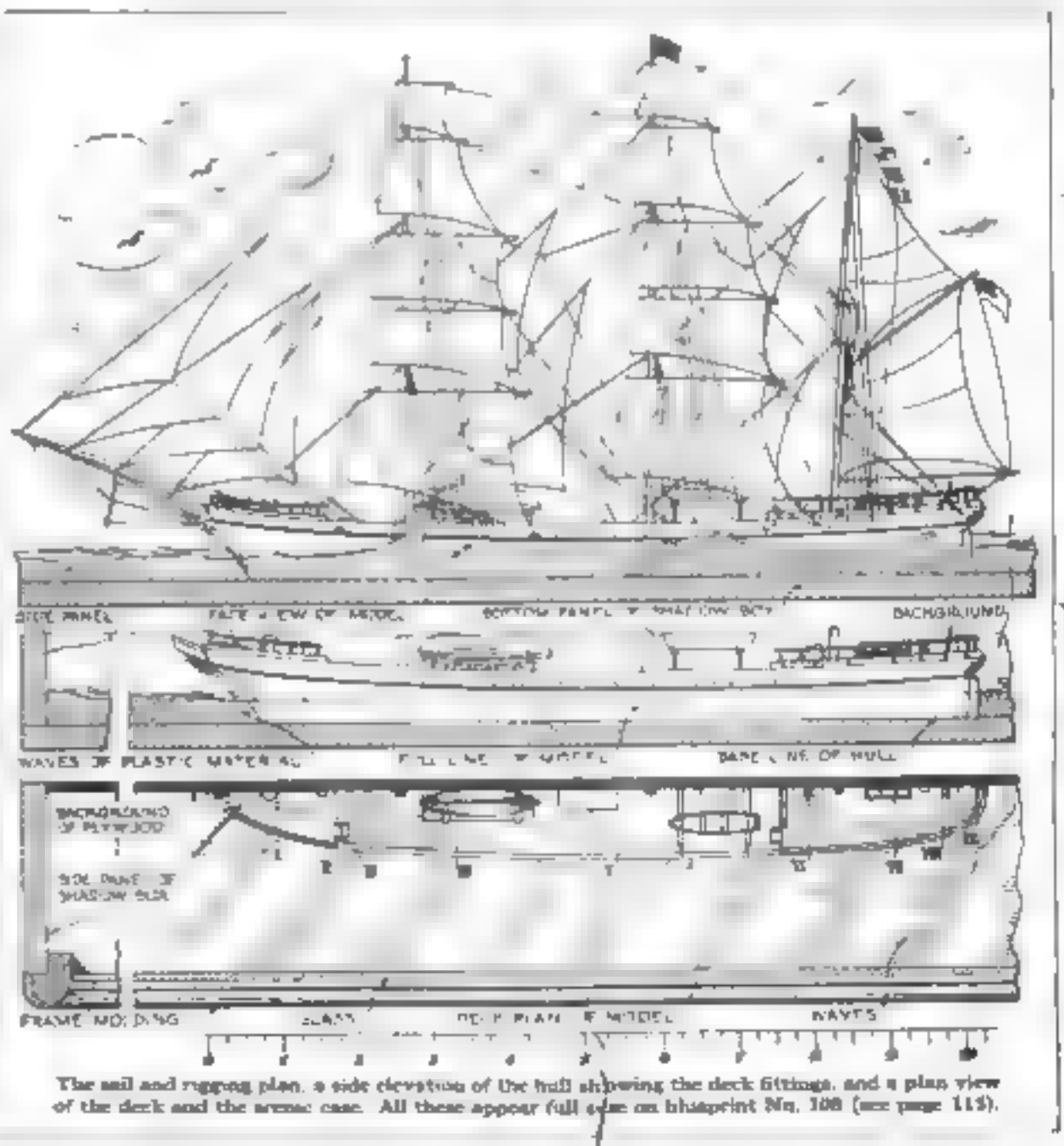
While the paint is drying we should get our show case ready. This is a shallow box about 2½ by 14 by 21 in. inside measurements. Any thin wood will do. A three-ply veneer panel is excellent for the back because it is not likely to warp or crack

It is easiest to paint the background before assembling the case, but if you do this all parts must be pegged or screwed as well as glued to it, because glue does not hold well on paint

To paint the back, give it one or more coats of flat white for a ground. Then with artist's oil colors put in the sky. In the original model the sky is light blue darkening to the top, with a little yellow ochre along the horizon and with white clouds (see page 121), although for decorative purposes a more brilliant color scheme is illustrated on page 79. If you like, you can add a few sea birds and some distant land. Carry the sky on the side pieces as far as the front edges of the case.

To this background glue and nail the half hull, with its lower edge about ⅝ in. up from the lower edge, or enough to allow for the bottom of the case. Fasten the deck furnishings in position.

The mast, bowsprit, and booms are shown full size on the blueprint. These should be made round and then shaved down a bit on one side, so that they are always more than half round. The topgallant, topmasts, and lowermasts may be made in one piece with steps, but it is an



The sail and rigging plan, a side elevation of the hull showing the deck fittings, and a plan view of the deck and the scenic case. All these appear full size on blueprint No. 108 (see page 115).

Half-model of the barque *Unrrotr*, a ship once commanded by Captain McCann, who is now known the world over for his success in popularizing the hobby of ship model making

easy to make them separate and glue and fasten them to the backboard with square staples, which will represent tops and caps. At the mizzen a couple of needle points will represent the crosstrees. Nail through the mastheads with pin points just below the royal rigging and fasten the jib boom similarly where the stays cross it.

The spars should be painted a brownish orange before being fastened.

Now for the rigging. This will be black thread (about No. 24). The rigging plan shows the stays and the backstays (note also the photograph on page 121). By boring into the background, the thread ends can be passed behind the spars for fastening. The forestays that come aboard by way of the dolphin striker are hooked under pinheads left projecting from the latter. The bowsprit shrouds are hitched to a stout needle driven into the ship's side to be along the cathead.

As this is an iron ship there are no channels at the fore and main and no

YOU will be greatly helped in constructing this picturesque half-model if you send for POPULAR SCIENCE MONTHLY Blueprint No. 108 (see page 115). This contains full size drawings with more details than it is possible to give in the magazine. Any of the other historic ship models listed among our blueprints also can be built as half-models by applying the principles outlined by Captain McCann in the accompanying article.

deadeyes. The shrouds and backstays come down inside the bulwarks. I fastened mine off by boring down from the waterways (at junction of deck with bulwarks) to the outside of the hull. Where the holes came through I cut a little groove, rove the backstays through, and tied them off in pairs. Then I puttied up the gashes. At the mizzenmast, however, the shrouds should come down outside over the channels and be plugged into the hull below.

The sails are whittled from soft wood, although the insides may be more easily scooped out if you use a flat gouge. Their full sizes and shapes are shown in the blueprint but can be estimated closely by using the scale of inches and the sail plan on page 78. The dotted lines indicate where they join the background.

All the sails belly out, the upper a trifle more than the lower. The yardarms are made part of the sails; that is, the blocks are cut with the round yard forming the upper edge. The outer and lower edges of the sails should be paper thin, but a little more body is left in the belly and at the midship edge.

The angle plan on the blueprint shows how the edges should be cut, each slightly different from the one below. That is because the ship is represented as "on the wind," that is, lying as close to it as possible—about five points. Thus the upper sails are almost along the wind, but those below are fuller.

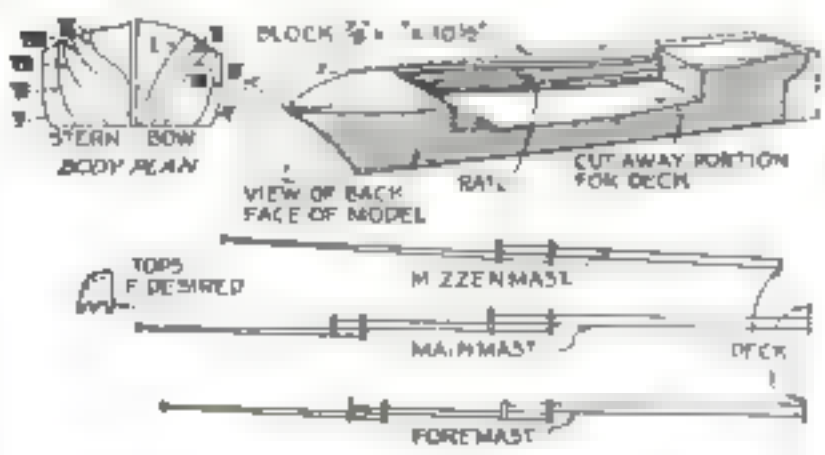
It is best to start with a lower sail (course), fit that, noting that the sheet lies outside the bulwark and at about the deck level. Then fit the lower topsail at the height of the top of the lowermast, with its sheet just touching the lower yardarm, to which it is fastened with a white thread. Tie it if you can drill a hole in the clew (lower corner); if not, use a touch of glue. Continue on up, having each sail touch the yard below and fastening each to the back with one or two wooden pegs as well as glue.

The fore-and-aft sails are made similarly, each to lie below, but touching, its stay, and with a sheet from the lower corner to the deck.

The spanker is best made with a separate gaff and boom to which it is fastened at the corners with thread.

The square sails may be given single braces as shown or double braces. Small beads will

(Continued on page 121)



Body or cross section lines of the hull at the nine station points indicated on the deck plan, the curved hull block and the masts

Sewing Cabinet Made *by* Machine

By WILLIAM W. KLENKE

Author of Art and Education in Wood-Turning

The cabinet sketched in pencil by the author. See page 104 for the full working drawings

Of all sewing cabinets the Priscilla is perhaps the favorite because of its Colonial grace

IF YOUR home workshop is equipped with a small combination woodworking machine or with individual machines, you can build the graceful little Priscilla sewing cabinet illustrated with practically no handwork except that required for cleaning up some of the material, assembling the parts, and applying the finish. And you can do it more accurately and speedily than with hand tools alone. Best of all, you do not need as much experience and skill to make a clean-cut craftsmanlike job.

What the new motorized machines are doing to create interest in the hobby of woodworking and what pleasure they can give the amateur craftsman were emphasized in "Your Motorized Workshop," an article published last month. This, the second article of the series, will explain the use of machinery in making what is probably the favorite of all sewing cabinets. The same methods, of course, can be used in constructing other small pieces of furniture of a somewhat similar character.

Roomy as this old Colonial piece is, it has the advantage of being easy to carry about the house from place to place. As is customary, it contains a sliding tray, divided into four compartments, for buttons, needles, and small accessories.

Mexican mahogany is perhaps the best material for this project, although you may substitute cheaper woods and stain them to imitate mahogany.

Step No. 1—Getting Out the Stock. On the planer dress one surface of each piece smooth and true and mark it with an X; this is known as the working face. Hold the marked surface against the fence of the planer and plane one edge at right angles to the working face. Mark this edge with an X, this is called the working edge. There are only two surfaces to mark.

Now go to the circular saw and, holding the working edge against the fence, rip the stock to the correct width, allowing 1/16 in. extra for the final planing. In like manner, obtain the thickness, if not already correct. Return to the planer and dress all surfaces smooth and true.

Follow this method for getting out all stock. At this point it is advisable to cut out cardboard patterns of all curved parts.

Step No. 2—Turned Legs. The stock should be at least ½ in. longer than needed to allow for turning the bottom end without striking the point of the dead center. Draw diagonal lines on both ends of the stock to locate the centers. Drill small holes at these points to receive the center pins of the centers. Square lines around the stock, locating the portions that are to remain square. Rough the stock with a gouge and turn to the design. Sandpaper thoroughly while in the lathe.

Step No. 3—Curved Feet. On the jig saw cut out the curved outline. On the drum sander smooth the edges just sawed. Use the disk sander for the flat edges at the top and bottom. If you are not already accustomed to these machines, you will be agreeably surprised at their speed and accuracy.

Step No. 4—Hopper Part. The end dado or box joints (see the detail drawing of the corner joints) can be made easily on the circular saw as follows: Set the circular saw a little over ½ in. above the saw table, and set the ripping gage at the proper distance from the saw blade, so as to make the four grooves on the end pieces. If your blade is thick enough, one cut will be sufficient. Now take the side pieces and cut the tongues or tenons to fit these grooves just made. The cut should be made in two operations to insure a perfect fit. Use the cardboard pattern for laying out the curves at the bottom of the end pieces and cut the curves on the power jig saw.

Ripping stock to width, the guard being removed for clearance. In circle Sanding joint edge of foot. At left below, Calipering one leg

Step No. 5—The Handle. The jig saw is a real help in the construction of the handle. Bore two ½-in. holes in the corners of the cut-out portion, insert the saw blade in one hole, and saw out the grip part. Next cut out the outside curve. Return to the drum sander and smooth all

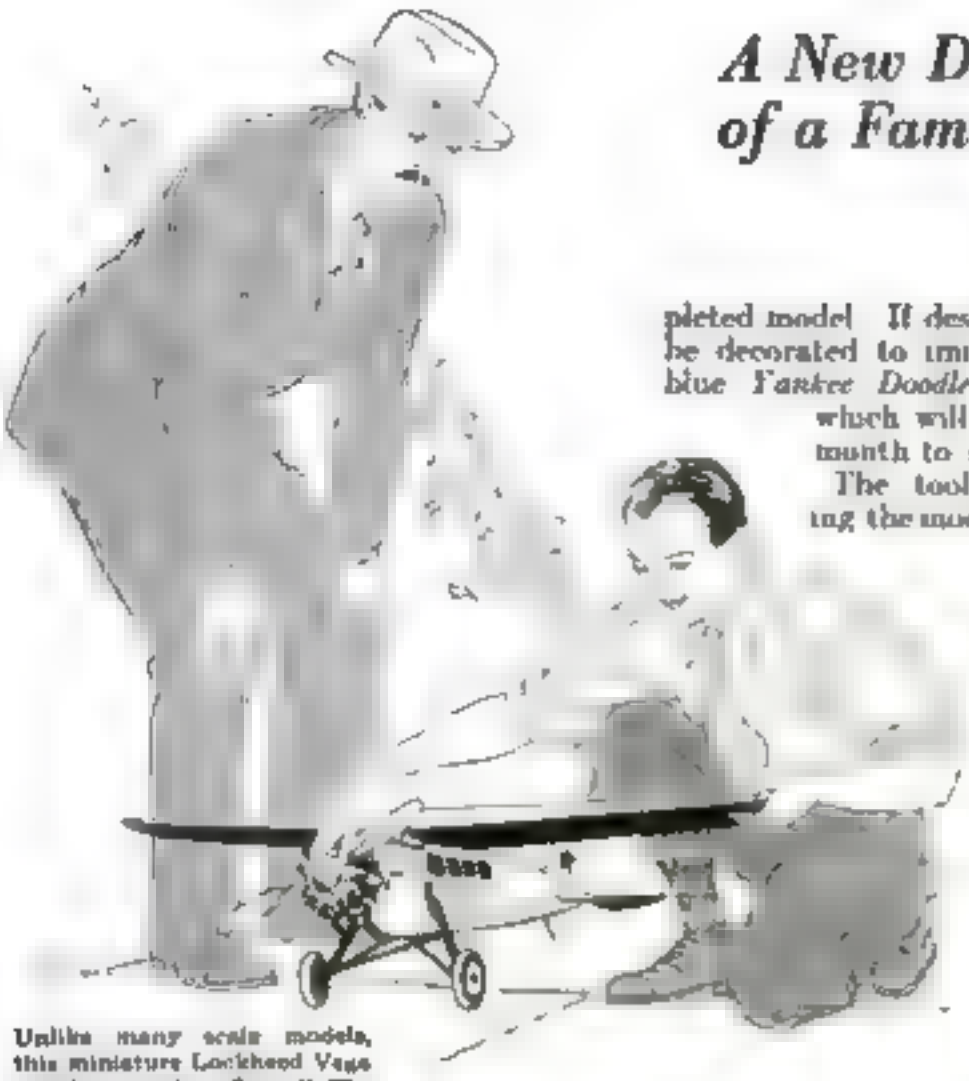
(Continued on page 106)

THIS is the second of a series of articles in which Mr. Klenke will explain how to operate both combination and individual woodworking machines. Through the courtesy of various manufacturers, he will illustrate the use of many machines that have been approved by the Popular Science Institute.

How to Build a *Lockheed* Model

A New Design for a Three-Ounce Replica of a Famous Plane—Flies Half a Minute

By VINCENT JOHNSTONE



Unlike many scale models, this miniature Lockheed Vega is light enough to fly well. The fuselage is hollow balsa wood

REALISTIC as it is in appearance and accurate in even minor details, the Lockheed Vega scale model airplane illustrated is also remarkable for its lightness and flying qualities. It can be constructed to weigh less than three ounces and will then fly for thirty seconds if hand launched.

Even to the method of constructing its fuselage, the model is similar to the *Yankee Doodle* and other famous Lockheed monoplanes. The large planes have a hollow bullet-shaped veneer fuselage, the model has a body hollowed from two large blocks of balsa wood.

Lockheed airplanes hold many records. Sir George H. Wilkins used one in his 2,200-mile flight over the North Pole in April, 1928; Col. Arthur Goebel flew from coast to coast in the *Yankee Doodle* in 18 hours and 58 minutes in August, 1928. Capt. C. B. D. Collyer, using the same plane, made another sensational nonstop flight in October, 1928, from New York to Los Angeles in 24 hours and 51 minutes, and Capt. Frank Monroe Hawks flew alone from New York to Los Angeles last June in 19 hours and 10½ minutes in a Lockheed Air Express, and almost immediately made the return trip in 17 hours, 38¾ minutes.

The wing span of the model is 31 in. and the over-all length 21 in. The wing is tapered and its curve is a special Lockheed design based upon the efficient Clark-Y curve. There is no sweepback and no dihedral except that caused by the tapering thickness of the wing section. The motor consists of four, six or eight strands of ⅛ by ⅛ in. flat rubber, depending upon the lightness of the completed model. If desired, the model can be decorated to imitate the white and blue *Yankee Doodle*, a photograph of which will be reproduced next month to show the markings.

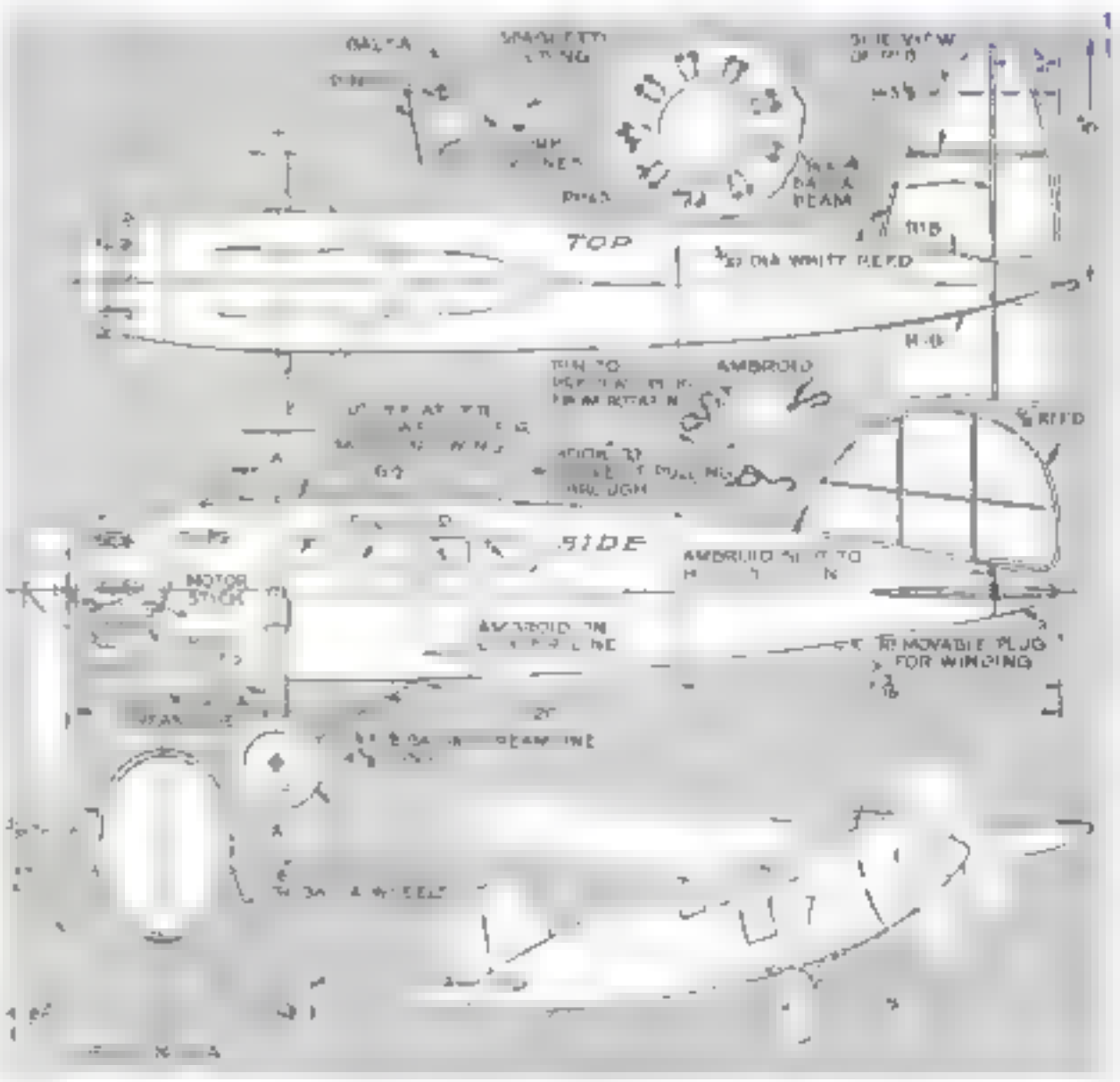
The tools required for making the model are a sharp knife, a ½- or ¼-in. carpenter's gouge, ruler and pencil, an outside caliper, round-nose pliers, wire-cutting pliers, scissors, small brush, several grades of sandpaper, and some pins.

Construction of the Body Follow the steps illustrated on page 128. Several paper or cardboard templates can be made to aid in obtaining the exact elliptical shape at several stations along the body and then the whole smoothed down carefully and uniformly.

Gouge the two halves out until the shell is extremely thin. Keep the gouge sharp and do not cut too much at one time. Finish by sandpapering. From the small end to the rear of the wing the shell should be about 1/32 in. thick; it should gradually taper from 3/32 to 5/64 in. at about the center of the wing and then to 1/16 in. at the front. Leave the rim somewhat thicker at the very front and at the rear so that a strong cemented joint can be made.

As the thickness of the shell away from the edges can be gaged only approximately, do the measuring accurately at the edges and gage the rest by holding the shell up to a strong light. Pencil mark the thickest places as indicated by the dark shadows and work them down until the shell is of uniform thickness. This is a reasonably accurate method because very little light passes through balsa wood 1/16 in. thick, whereas considerable passes through a 1/32-in. thickness. Coarse sandpaper will work down the balsa wood quickly to the

(Continued on page 127)



Top and side views, a cross section, and details of the dummy engine construction and the rear plug. The sketch shows the fully assembled model, the wing of which will be described in the October issue.

Popular Science MONTHLY

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Laws That Cannot Live

ELSEWHERE in this issue, Orland Kay Armstrong reviews the extraordinary situation that has arisen in Arkansas from the passage of a law prohibiting the teaching of the theory of evolution in state-supported schools. A number of teachers, bitterly opposed to the measure, have devised ingenious schemes to evade it in their classrooms this fall, if they can do so without getting into trouble.

A public school, however, is a poor place to keep a secret, and it requires no great gift of prophecy to predict that, before long, at least one of the rebellious instructors will be arrested for teaching the forbidden theory. Then the country once more will witness the strange spectacle of an educator on trial for teaching a doctrine which was advanced by Charles Darwin sixty-nine years ago and since has been accepted by leaders of thought as the cornerstone of almost the entire structure of biology and allied sciences.

Those responsible for laws like the new Arkansas statute hold that the theory of evolution is a direct contradiction of the Biblical story of creation and, therefore, strikes at the foundations of religion. Evolutionists reply that the theory offers no challenge to religion or to belief in a Creator. They admit they cannot literally accept the Genesis story of the creation of the world in six days of twenty-four hours, and of the separate creation of man and the animals. But they have declared time and again that, by interpreting it liberally, they can believe fully in a Creator who, in six geological eras, made a world where the processes of evolution continue indefinitely.

No law devised to stifle knowledge ever lived long. The people of Arkansas soon will discover that their antievolution law is no exception.

Will Robots Hold the Stick?

A FAMOUS aviation authority recently declared there are only one hundred and fifty competent air pilots in America.

"Flying sense" is a rare possession. Man's system has been associated with the ground for millions of years, with the air for only twenty-five. A pilot of wide experience tells of glancing at his instrument board while flying through a cloud bank. He discovered he was going into a tail spin. His senses had given no warning.

The first thing impressed upon students of "blind flying"—flying by instruments alone—is that the instrument board, not their bodily sensations, is the reliable guide to their flying position. It seems likely that the work of human pilots may some day be limited to taking planes into the air, avoiding collisions with other machines while in flight, and landing at the terminal airport. The big planes of the future probably will speed through the sky with mechanical robots, governed by instruments, holding the stick.

Keep to the Right

WHY do so many persons living in crowded cities walk on the left or wrong side of pavements? And why, when they do it, does not a bit of common sense make them realize that they are "bucking" traffic?

In the United States, the rule of the road is "walk or drive to the right." Yet thousands of pedestrians in our large cities persist in walking to the left for no logical reason.

Left-side walking slows up both pedestrian and vehicular traffic, to say nothing of causing personal bumps, shoulderings, and collisions. Very often you see crowds, held on both sides of a street crossing by traffic, suddenly rush across when the signal changes and meet in confused collision in the center. If every one would keep to the right, the crossing could be effected much more easily and safely.

Control of congested traffic has become a scientific problem for engineers. But their best systems are doomed to failure unless drivers and pedestrians use ordinary common sense.

Keep to the right.

Insulting a Good Watch

MANY radio broadcast stations announce the time, every so often, "as given by the"—and then follows the name of a watch or clock, depending on who is paying the bill.

It might be a very valuable service, but unfortunately officials of some of the stations do not seem to recognize any difference between the time keeping qualities of a fine watch and a dollar alarm clock. And the inaccuracy of the signals they so carefully announce by means of chimes or gong indicate that they don't even bother to get a good alarm clock.

Just the other night one of the largest stations, announcing the time, erred exactly one minute and twenty-two seconds. Imagine setting your watch accordingly and then attempting to make a close train connection!

Why insult the name of a good watch? There is no excuse for an error of more than two seconds—Government time signals rarely err more than a fifth of a second!

They are Saying—

"AT PRESENT the airship should be confined to long-distance transoceanic flights, while the airplane should be restricted to short distances over land."—Commander C. E. Rosendahl, U. S. N., in charge of the Lakehurst Air Station.

To me, Mr. Edison is worth giving up whatever greater wealth or rewards I might have attained if the years had been spent differently."—William H. Meadowcroft, Thomas A. Edison's right-hand man for forty-eight years.

"The black magic of the Middle Ages seems pale and commonplace in comparison with all that modern chemistry is shortly to achieve."—T. W. Jones, author of *Hermes, or The Future of Chemistry*.

"The common run of American doctors is not as well trained in obstetrics as are the midwives of Sweden."—Dr. Howard W. Haggard, of Yale University.

"The transient population of New York City burns up bodily energy twenty percent more rapidly than the average resident because of the effect of city noises upon the nervous system."—Dr. Wallace B. House, professor of neurology and psychiatry at the New York Homeopathic College.

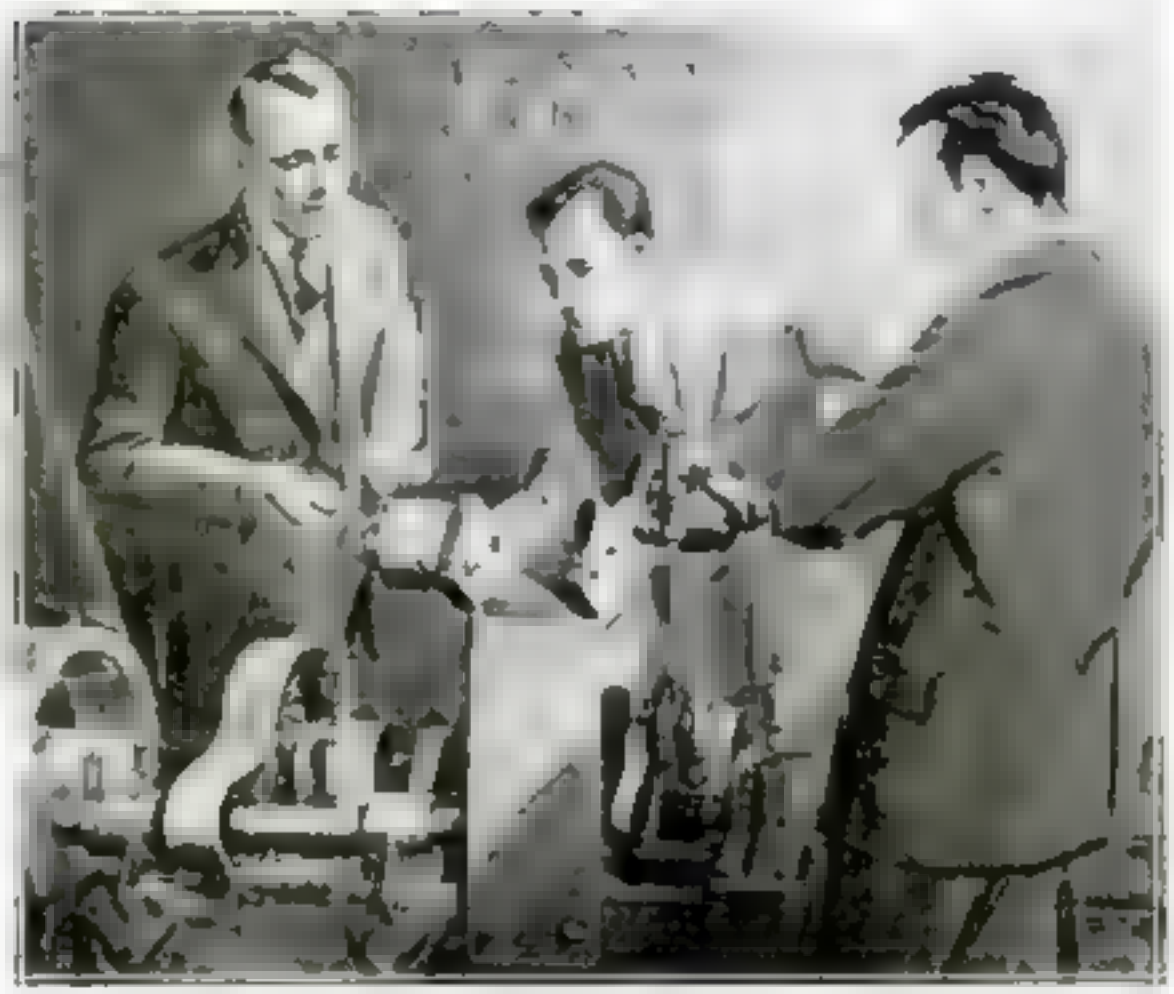
"There is something fascinating about flying over the jungles with pastors and medical missionaries carrying not only supplies and medicines, but enlightenment and religion to the savages."—Capt. Hermann Koehl, German trans-Atlantic flyer going to Africa as a real "sky-pilot."

"Transit delays and crowded subway cars sap the energy of girls before they reach work."—Neal Dow Becker, president of the Intertype Corporation.

"Many persons who suffer from insomnia do so because they are too particular about becoming perfectly comfortable."—Dr. Edmund Jacobson, of the physiology department, University of Chicago.

Years of punishment

jammed into HOURS *and* MINUTES



The long life and performance of Houdailles is not a guess. In the great automobile plants terrific break down machines literally pack years of punishment into hours and minutes while automotive engineering authorities study shock absorber performance.

HOUDAILLE hydraulic double-acting shock absorbers assure you of supreme riding comfort as long as you drive your car.

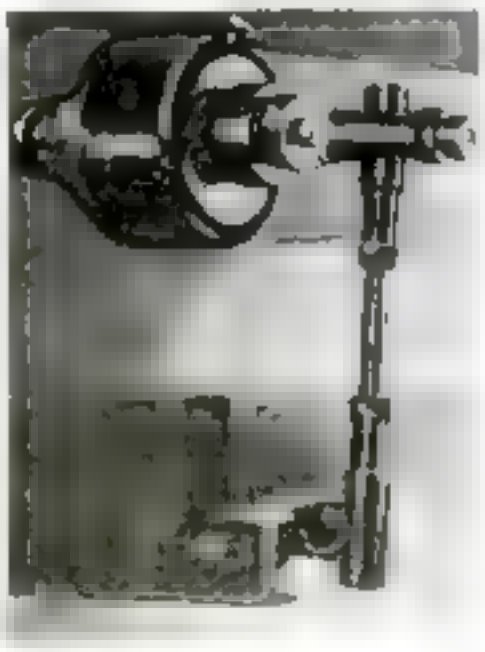
The "break down" test machine compares the life of shock absorbers by packing years of terrific driving punishment into hours and minutes. The unusually long life of Houdaille hydraulic double-acting shock absorbers on the "break down" machine is confirmed by their accomplishments over the years on millions of automobiles.

Some of their mechanical features which have made them *the world's standard of comparison* are . . .

1. The double or balanced piston which reduces wear to a minimum by balancing the working pressure on both sides of the shaft, thus eliminating one-sided thrust.
2. The large capacity reservoir which holds a reserve supply of fluid and makes it unnecessary to pack the instrument against the high working pressures.
3. The patented air vents and replenishing valve which allow for the escape of air and gases and make the instrument *truly hydraulic.*
4. The easy adjustment for accurately adapting their resistance to your individual car.

Houdaille shock absorbers are the result of 27 years of pioneering. Not in the experimental stage—Houdaille hydraulic double-acting shock absorbers assure you of the smoothest ride over the roughest roads to anywhere.

Your Car Dealer can supply Houdailles at the new lower prices . . $40, $50, $75 and $100, plus installation. Slightly higher west of the Rockies and in Canada.



Houdailles have been adopted as standard equipment by the engineers who build Lincoln, Pierce Arrow, Cunningham, Jordan, Ford, Nash Advanced Six, Chrysler Imperial, Studebaker President, Graham Paige and many European cars.

HOUDE ENGINEERING CORPORATION,
BUFFALO, N. Y.

HOUDAILLE

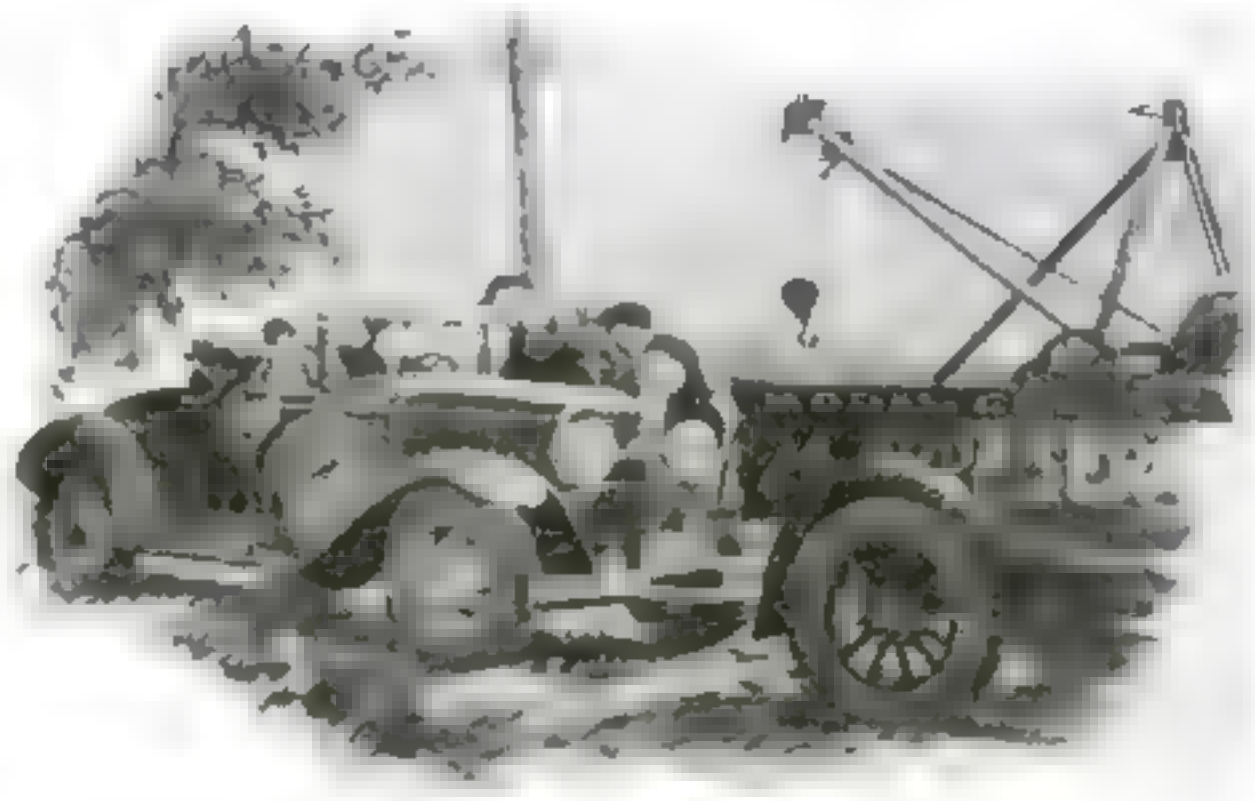
Hydraulic Double-Acting **SHOCK ABSORBERS**

How to Tame a Rough-Riding Car

A "High Brow" Learns from Gus the Trick of Smoothing Bumps with Shock Absorbers

By

MARTIN BUNN



"This is very complicated," Gus frowned. "The induction of the requisite amount of combustible into the carburetor is impeded by a deficiency in the supply of the necessary liquid."

THE young man behind the wheel repeatedly jabbed his toe down on the self starter button until, in the end, the battery became so exhausted that it refused to spin the motor at all. And with each succeeding failure he became more flushed and embarrassed.

"You can have no idea how much I regret this unfortunate situation, Miss Wilder," he apologized. "Apparently some portion of the mechanism has become disarranged and in consequence the motor refuses to perform the function of propulsion."

"You mean it's busted?" suggested the pretty girl who occupied the other half of the sporty roadster's seat. "Then hadn't you better phone for some one to come and fix it? There's a house down the road that has a telephone, I'll bet."

"Your suggestion is most appropriate. I shall proceed to act on it at once," he agreed, as he hastily climbed out of the car and headed for the farmhouse.

Lucille Wilder gazed after him with a puzzled expression in her eyes. "Gosh!" she exclaimed to herself. "He's a funny sort. Must have swallowed the whole dictionary. Never heard so many different words in my life!"

Joe Clark answered the phone at the Model Garage.

"Jason? H. Seymour Jason, did you say? Yes, we'll be right out with the service car."

Joe Clark popped out of the little office at the Model Garage with a broad grin on his face. "Hey Gus!" he called to his partner, Gus Wilson, the veteran auto mechanic. "This ought to be good! Do you know H. Seymour Jason, the town high brow? I don't know how come, but he seems to be busted down out near Parkville with a flapper in the car. Didn't know he had a car and he always bragged about having no use for women."

"The louder they brag, the harder they fall," grunted Gus, as he cranked the engine of the service car.

WHEN they reached the disabled car, Gus made a careful examination. Then he got Joe around to the back of the car and silently pointed to the gas gage. The tank was empty. "Slip a gallon or two into the tank while I keep 'em busy in front," he whispered. "With that funny dictionary lingo he shoots, the poor fellow'll have a hard enough time making a hit with a girl without us making him out a bonehead."

Gus opened the hood again and began fussing with the vacuum tank. "This is very complicated," he observed with a frown. "The induction of the requisite amount of combustible into the carburetor is impeded by a deficiency in the supply of the necessary liquid flowing through this orifice which leads to the main receptacle."

Jason stared at him for a moment while his face took on an even more brilliant red. "You mean——"

"Yes, that's it," Gus interrupted hastily. "Besides that, your shock absorbers are on the blink. Car rides kind of hard, doesn't it?"

Now that you mention it, Mr. Wilson," said Jason, "I have noticed that the car goes through more than the usual amount of vertical motion when we pass over protuberances in the road."

Gus removed the pipe leading from the vacuum tank to the intake manifold and sucked on it until the vacuum tank filled from the gas Joe had put into the main tank. The battery had recovered sufficiently to start the motor.

The next day Jason appeared at the Model Garage.

"I wish to thank you, Mr. Wilson," he said, in his wordy way, "for handling the situation so diplomatically that my ignorance was not revealed to the young lady. To tell the truth, I purchased the car in order to promote her good opinion of me. So far, I fear I have not been very successful. The car rides so uncomfortably that I have been unable to carry on very much conversation."

Gus winked at Joe. "That," slyly observed the gray-haired mechanic "probably is a blessing in disguise. As for the shock absorbers on that car, I can fix 'em all right."

JASON grinned sheepishly. "Perhaps you're right," he admitted. "However, I will deem it a favor if you will explain just how a shock absorber accomplishes the desired result. I confess I'm somewhat confused on the subject."

"Nothing remarkable about that," grunted Gus. "Lots of motorists are in the same boat. Most of 'em, in fact, or they wouldn't buy so many phoney shock absorbers that anybody with the slightest knowledge of mechanics could see are no good.

"Most everybody knows what a spring is. If you ever went off the end of a springboard when you were in swimming, you know how you jumped on the end of the board and your weight pushed it down. Then the board snapped back and threw you into the air.

"Car springs *Continued on page 143*

Ask Gus—He Knows

THERE'S no sense in letting people walk all over you, but it won't get you anywhere to be too finicky about your rights when you're behind the wheel of an automobile. Lots of drivers go round with chips on their radiators instead of on their shoulders just waiting for the other fellow to crowd 'em or cut in on 'em. Maybe you have got the right of way—maybe the other fellow is hogging more than his half of the road—but what's the use of wasting energy pawing about it? The other fellow may be a new driver—you were yourself, once. He's got worries and troubles same as you have. Try meeting 'em a little more than halfway!

RCA

Look for this mark on every Radiotron

CHARLES EDISON

President THOMAS A. EDISON, Inc. Says:

"Before releasing them to our dealers we test the performance of Edison receiving sets with RCA Radiotrons. We do this because they do full justice to a product of which we are proud. So that purchasers may receive maximum satisfaction from our instruments we recommend to our dealers RCA Radiotrons for initial equipment and for replacement."

Charles Edison

The leading makers of radio sets sold on a quality basis use and recommend RCA Radiotrons for tests, initial equipment and for replacement. If you wish to get the finest performance of which your receiving set is capable, replace all of your vacuum tubes once a year at least. Old tubes left in with new ones impair the efficiency of the others.

RCA RADIOTRON

RADIO-VICTOR CORPORATION OF AMERICA NEW YORK CHICAGO ATLANTA DALLAS SAN FRANCISCO

Reproducing a *Rare* Old Clock

How to Construct a Duplicate of a Genuine Eli Terry Pillar-and-Scroll Shelf Case and Fit a Ready-Made Movement into It

By FREDERICK J. BRYANT

Authentic Terry shelf clocks are highly prized because of their rarity and their decorative value in any Colonial setting

ANYONE who is interested in antique furniture will recognize this shelf clock. The design was made and perfected by Eli Terry, one of the most noted of the early clock makers in Connecticut.

Terry's "pillar-and-scroll" shelf clock was first made in 1814. Seth Thomas, another clock maker, paid Terry one thousand dollars for the right to use this design. The first year the shelf clocks were put on the market these two men made more than six thousand of them. The selling price was fifteen dollars each.

Genuine Terry shelf clocks are not easy to purchase because their owners prize them highly. It is interesting to see the number of reproductions on sale in the stores, but the copies are as a rule about one half the size of this one. Even so the effect is pleasing, and anyone interested in this design can make the case half size if he wishes.

The clock movement should be an eight-day wind. The dial, of thin wood or metal, measures 11 ½ in. square. One can be made by pasting a piece of the finest white drawing paper on a sheet of zinc and doing the necessary drawing in India ink with compasses and rule. In each corner a small floral decoration in colors should be added. This trouble, however, may be avoided, for dials, pictures, brass ornaments, mahogany veneer, and pillars can be purchased at reasonable cost.

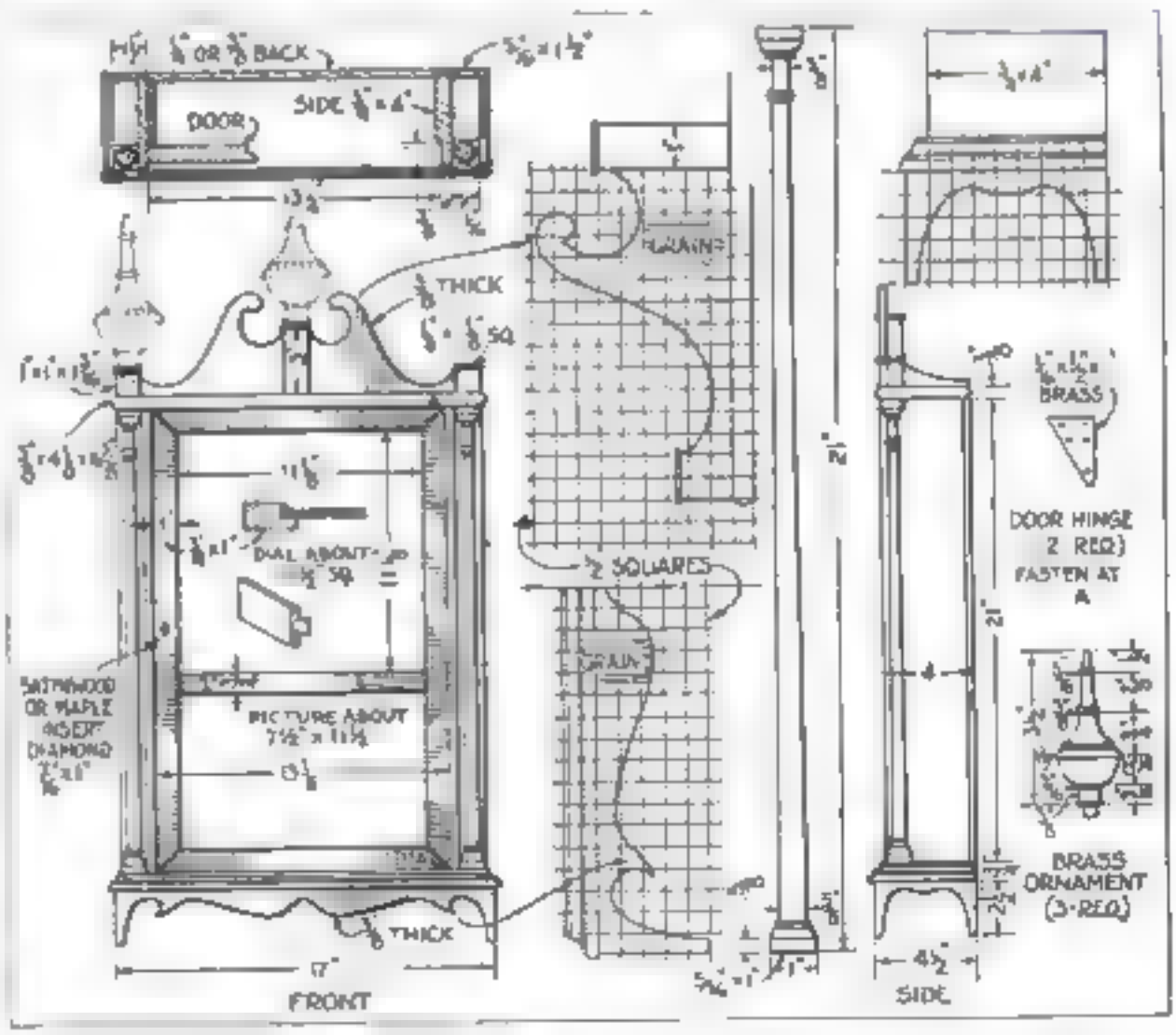
The picture in the space below the dial was always painted directly on the glass. A colored picture of Mt. Vernon, George Washington's home, is well adapted for this style of clock.

The making of the case is easy and the materials (see the list on page 134) should not be difficult to obtain. Your lumber dealer can obtain the veneer for you, if he does not have it in stock. Ask for three-ply ⅛-in. stock.

In making any clock, particularly one of this type, it is advisable to purchase the movement before beginning to construct the case. On the drawing and in the bill of material the width of the sidepieces is given as 4 in. This was the width of the sidepieces on the original clock, but it does not provide a sufficient depth for present-day movements. Obviously, the easiest way to obtain sufficient depth is to increase the dimension to 5 in., but that will not satisfy the craftsman who wishes to make a perfectly proportioned reproduction.

Another way to gain more space is to cut through the back to make an opening into which the movement can project. Additional clearance can be obtained by adding a wooden rim of the necessary thickness around the opening at the rear. After the works are in position, this opening can be covered with a sheet of zinc.

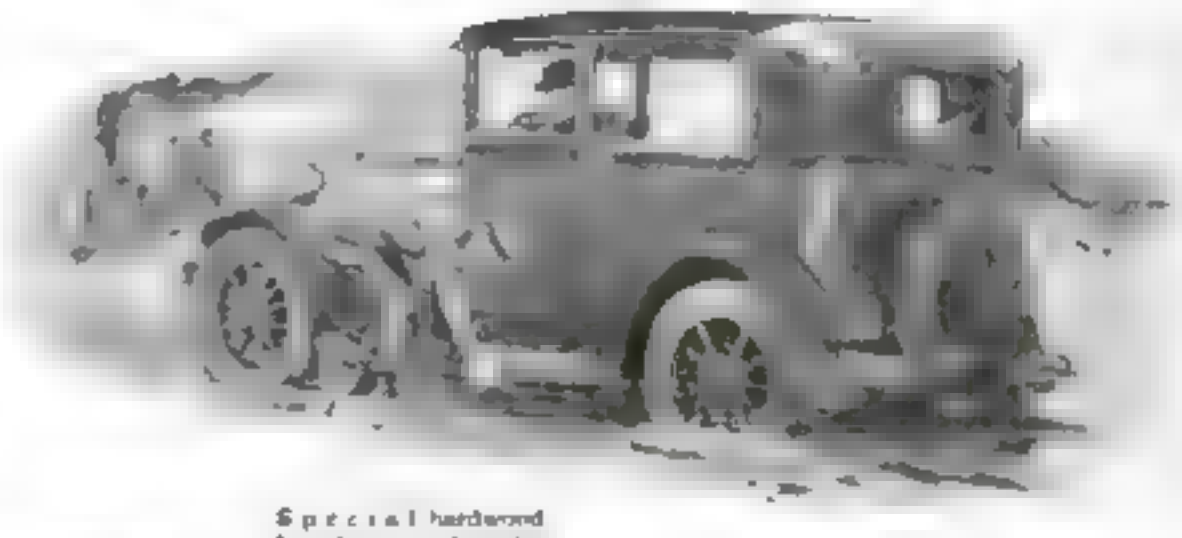
Prepare two pieces ⅝ by 4 by 21 in. for the side of the case. If you use ⅛-in. veneer you will have to glue additional stock on the inside surface to make up the ⅝-in. thickness. Some work can be saved by purchasing a small amount of ⅛-in. veneer for the case sides and door. Notice that the front edges of these pieces are cut away for the door and a similar groove or rabbet is made (Continued on page 134)



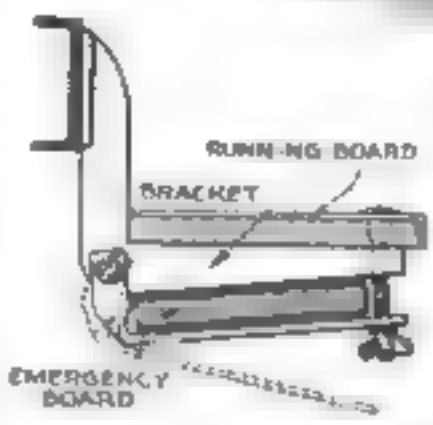
Measured drawings of a genuine Eli Terry pillar-and-scroll shelf clock made about 1814. The wood used is mahogany except for a few hidden blocks. An itemized list of materials appears on page 134

When You're Stuck in a Mudhole

Here's an Emergency Device That Will Get Your Car Out—Other Ingenious and Useful Ideas for Motorists



EVEN the motorist who sticks to the main highways sometimes encounters a mudhole on a detour, so that the idea shown in Figure 1 for extricating a mired car is one which any auto owner may find useful. As indicated in the diagram, brackets are built with clamps to hold special boards beneath the running boards. These special boards should be of good hardwood and should be covered on both sides with wire lath. If only one wheel becomes stuck in the mudhole loosen the clamps holding the board on the side that is stuck and shove the board under the wheel for traction. You will find that the wheel will ride out of the hole. If both wheels are stuck use the boards on both sides. The wire lath is necessary on the top of the board to give the tires traction, and is needed on the bottom to keep the board from sliding through the mud.



Special hardwood boards, carried under the running boards for emergency, are useful in freeing a mired car

Fig. 1. This diagram shows how the emergency board is carried. Wire lath on both sides gives traction

Novel Gasket Repair

AN EMERGENCY repair for a torn fabric gasket, in the event that a new one cannot be obtained, can be made by placing a piece of wire netting over the tear, as shown in Figure 2. With care a gasket replaced in this manner will hold for some time with little sign of leakage.

The wire netting serves to prevent the pressure from blowing the ends of the gasket out and causing a bad leak. Of course, this method will not work with a copper asbestos gasket that is in need of repair, but it will do the job with any of the fabric gaskets such, for instance, as the one used on the oil pan.

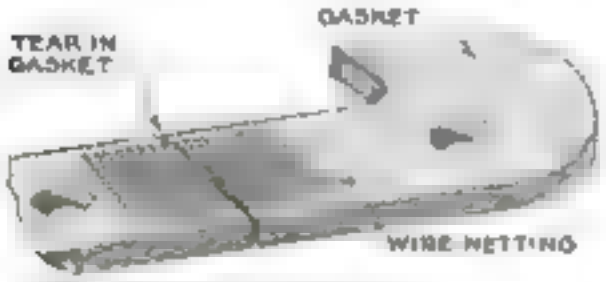


Fig. 2. How to mend torn fabric gasket temporarily by placing wire netting over the tear

Ball an Aid to Steering

THE only way of assuring ease in steering with modern balloon tires is to have the gear ratio between the steering wheel and the front wheels extremely low. This means that you must turn the steering wheel a considerable distance in maneuvering the car. In ordinary driving this extreme steering motion causes no inconvenience, but if you have to maneuver the car back and forth several times to get into and out of your garage you will find that an aluminum ball, fitted as shown in Figure 3, will prove a big help. You can grasp the ball and spin the steering wheel the necessary amount without releasing your hold.

MAX CHARLES PRICE, of Punta Gorda, Fla., wins this month's $10 prize for his suggestion for extricating a mired car, shown in Fig. 1. Each month POPULAR SCIENCE MONTHLY awards $10, in addition to regular space rates, for the best idea sent in for motorists. Other contributions used are paid for at the usual rates.

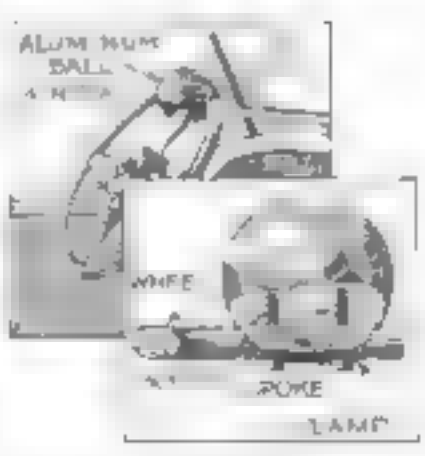


Fig. 3. Aluminum ball attached to the steering wheel aids in spinning wheel to turn the car

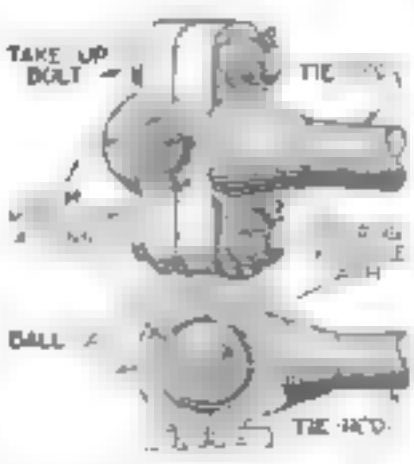


Fig. 5. A penny inserted under ball cap of steering apparatus serves as shim to stop play

A Simple Homemade Jack

THE design for a homemade jack you can build easily from a few pieces of two-by-fours is shown in Figure 4. It is excellent if you have occasion to jack up your car quite frequently. A pair of these jacks will permit you to jack up both rear wheels or both front wheels at the same time for brake adjustment, and if you properly proportion the jacks to your car you will find that they can be worked very easily.

Of course a jack of this type is not suitable for general service because the throw is short. It is useful only where you wish to push it under the axle when the tire is inflated and lift the wheel a small distance from the ground. The longer the distance from the framework to the lever lock the easier will it be to jack up the car, and of course the shorter will be the distance that the car will be lifted. The uprights can be nailed or bolted to the bottom piece. If the latter, use a half-inch diameter bolt as a pin for the lever.

Fig. 4. A simple way to make a handy garage jack from two by fours

Penny Makes a Shim

WHEN you find that the ball cap on the steering apparatus fails to hold the ball on the end of the tie-rod tightly enough to prevent play, the trouble can be eliminated by taking off the cap, placing a penny over the ball, and clamping the cap in place again, as in Figure 5. The pressure will force the penny into a cup shape so that it will act as a liner for the ball cap. Use a piece of sheet copper or brass if less thickness is desired.

A stone lantern of great age in a tiny but exquisitely beautiful Japanese garden.

How *to* Light *Your* Garden

At Small Cost You Can Make a Softly Glowing Pedestal Lantern in Japanese Style

By HI SIBLEY

THE pedestal lantern is a feature of every garden in old Japan. The writer has seen as many as seven in a space not larger than 10 by 15 ft. Most of these lanterns are of stone and as old as history, but in the newer homes one finds picturesquely quaint designs in wood. The stone lantern is a costly accessory for the average American garden, but one of wood can be constructed easily and inexpensively. It strikes a picturesque note in a group of shrubs and is particularly effective at the back of a rock garden. When possible it should be located on a raised ground.

In Japan artistic use is made of maple or *momiji*, and of cedar known as *sugi*. Generally the wood is left unpainted and in time assumes a beautifully delicate weathered appearance. However in our gardens we often wish a touch of color and in this case a color scheme is presented in which Oriental shades predominate.

Redwood or cedar is satisfactory for this lamp, whether left in the natural wood or painted. Begin with the baseboard, a piece 1 in. thick by 12 in. square, and to the bottom of this nail another piece ¾ in. thick and about 7 in. square. The grain of these two pieces should be at right angles to each other to prevent splitting.

Three frames are built of four ½ in. thick pieces each. Note that only the side frames are shown in detail. The front is made 1½ in. narrower by reducing the width of the upright pieces to 1 in. End lap joints are used and these are glued and reinforced with screws.

The front corner joints are covered by plain strips of molding stock ¾ by 1 in. fastened where they meet edge to edge as indicated. Strips ½ in. square serve to fit the walls together and to the baseboard on the inside. First however the window bars should be made of ⅛ by ¾ in. strips and half lapped together.

The door at the rear, which allows bulbs to be changed, can be made of solid wood if the lantern is placed with its back to the wall or a thick hedge. Set a porcelain socket on the baseboard.

To fill the frames, opalescent or ground glass is preferred to clear or colored glass. Beveled strips hold the glass in place.

The roof framework is made up of three parts: one main member and two triangular pieces which are nailed to it at right angles. Clear cedar packing-box boards are suitable for roof sheathing, some these are available in tongue-and-groove material. No other roof is necessary.

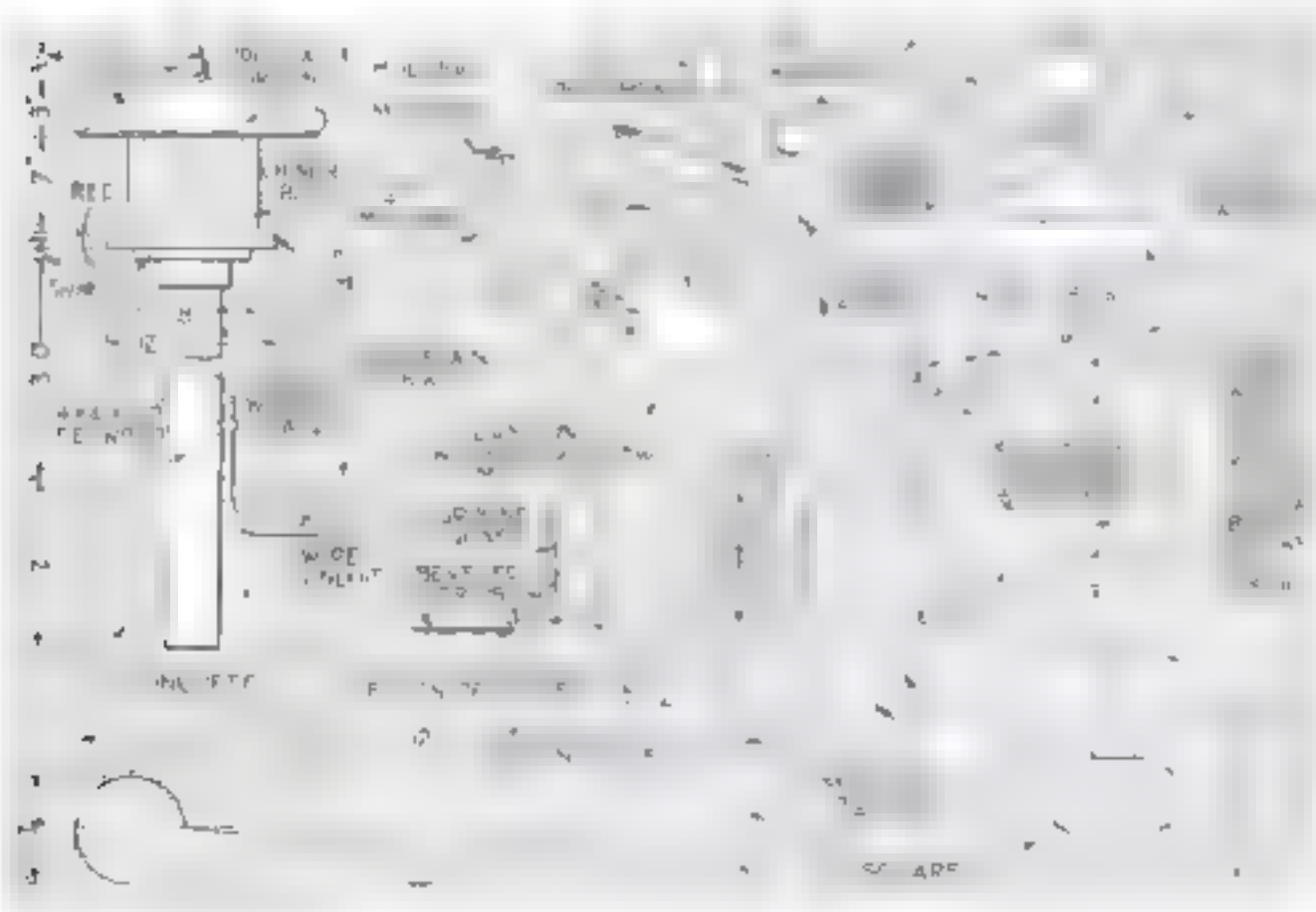
Ornamental pieces ¾ in. thick cover the joints of the roof boards, and the whole is surmounted by a piece turned on a lathe. The baseboard, of course, should

A simplified garden lamp of wood any handy man can construct easily.

be nailed to the post before the roof is placed.

It is not absolutely necessary to set the column in concrete but desirable to do so if you have any Portland cement handy. Wires should be run through an iron ground conduit for neatness, overhead wires would ruin the effect.

Whether to paint or not is a matter of personal taste. It depends largely on the setting. But painted or not, the lamp will probably add more to your garden than any other single feature.



A homemade electric garden lantern set up on a wooden post, with suggested dimensions and details showing workmanlike ways to make and assemble the frames for the glass, the roof and the ornaments.

This is the Clayton & Lambert No. 60 fire-pot with plumber's shield. Tank capacity one gallon of gasoline. Burns six hours full capacity without refilling. The shield can be detached, and the handle locked, so that coppers can easily be heated.

Your eyes won't tell you half

WHEN you look at a Clayton & Lambert fire-pot you'll notice its sturdy construction. Right away, you'll say to yourself, "Here's a tool that'll stand rough usage." But doing that isn't even half of a Clayton & Lambert's job. The rest is better performance. That's made possible by patented improvements—exclusive C & L features of design. It's those improvements which make Clayton & Lambert's chock-full of satisfaction.

For instance, the unique method of mixing air and gas vapor and the patented C & L baffling cup. They produce a working-hot flame in *ninety seconds after priming!* And you do that every time, regardless of high winds, cold weather, or draughts. For a Clayton & Lambert's special construction eliminates "popping" and back-firing. And fire-pot No. 70 has a special gas orifice. No matter how tight or carelessly you close the valve, the fire-pot can't be ruined. Another example of C & L improvement is the patented "spider" welded to the tank. That with the drop-forged uprights keeps the top-structure properly aligned and all working parts in perfect true. Even a pretty hard bump won't faze a Clayton & Lambert. And both Nos. 60 and 70 are noiseless, odorless, and smokeless. They can be used indoors without annoying a soul.

Clayton & Lambert No. 22 is a high-powered, coil-type fire-pot. It's one of the most up to date and popular Clayton & Lambert models. One big improvement is a door in the coil cup. It permits you to change the coil by loosening a nut and withdrawing the coil through the door.

These are just a few Clayton & Lambert improvements. And you'll appreciate them the more you use a Clayton & Lambert. You'll get to depend on your Clayton & Lambert so much that you won't want to work without it. Be sure you get a Clayton & Lambert by looking for the red band around the base of the tank. And look for the C & L trade-mark too. Then you're sure of the satisfaction that has made Clayton & Lambert the world's largest selling fire-pot line. At plumbing, tinners' and mill supply stores.

This is the Clayton & Lambert No. 22 fire-pot. It is deservedly popular because of its sturdy understood design and its powerful blast. Recent improvements and Clayton & Lambert patented features make this model particularly desirable. One of its finest devices is the door in the side of the coil cup. That permits the coil and burner to be easily removed for cleaning. Sturdy construction and popular price make this tool a favorite with the plumbing trade.

CLAYTON & LAMBERT

MANUFACTURING Co., Detroit, Mich.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Hammering Bowls

How to Shape Them by the "Raising" Method from Disks of Sheet Metal

By EDWARD THATCHER

Fig. 1. Stake, disk and raising hammer in the correct position for starting to form a sheet metal bowl

Fig. 2. When the edges of the disk become wrinkled the flutes are hammered out flat on the stake with a wooden mallet

MOST fascinating of all operations in decorative metal work is that called "raising." Those of you who have tried it will agree with me. I feel sure and those who haven't will be amazed to discover what can be done with a disk of sheet metal, a hammer and a stake—nothing more.

Not long ago I had the pleasure of seeing a fine vase or high-necked pitcher of marvelous craftsmanship made by a professional hammer man who had spent four years as an apprentice in a silversmith's shop. This silver masterpiece was perhaps 12 in. high yet it had been beaten from a single disk of metal of the size and thickness of a penny.

Naturally you will have to begin with simple work, but if you are accustomed to using tools and especially if you have made some of the projects outlined in previous articles in this series, you will find much pleasure in raising your first bowl and will quickly gain an intimate knowledge of this always surprising and alluring branch of the craft.

Start with a bowl shaped as indicated in Fig. 7 and not larger than 3 in. in diameter. Make a drawing the exact size.

Sheet copper of about No. 18 B. & S. gage should be used, it is very soft but tough. Brass is more springy and harder to hammer, but, of course, brass, silver, gold, pewter and other metals may be hammered up or raised. I have made attractive bowls of mild steel, but that was much more difficult.

To find the proper size disk, add together the diameter of the base and twice the height; in this case 2 + 2½ + 2½ = 7 in. Cut out a disk of this size, anneal and pickle it, and scrub it clean and bright with powdered pumice stone and water. Make a slight mark with the center punch in the exact center and scribe a circle 2 in. in diameter in the center on one side. You have to scribe a new 2-in. circle for the base each time the bowl is annealed.

If you wish to make a very accurate job, cut out cardboard templates as indicated at *I* and *II* in the upper left hand drawing of Fig. 7 and try one or the other on the bowl as you work.

Place a stake shaped like that in Fig. 1 between the jaws of a very heavy vise or in a stake holder made from a log of wood. Take up your raising hammer, keep the elbow close to the body and hold the disk of copper resting on the stake in the position shown in Figs. 1 and 7. The edge of the base circle should rest just over the edge of the stake, which you will notice has a slightly rounded top.

Try to hold the raising hammer in such a way that the face of it (which is flat with rounded edges) will come down flat against the surface of the metal on the stake. This is very important. If the face of the hammer does not hit the metal squarely, the edges of the head are apt to cut deep gashes in the disk.

Now start hammering all around the edge of the circle scribed as a base line, but do not hammer inside this circle at all. Each time that the hammer strikes the metal it drives a small portion of it down to the stake under it, consequently you must hit the metal *always slightly away from the stake*. Some part of the work is always resting on the anvil to support it as you hold it, *but not that part where you are to strike with the hammer*—that is, unless you wish to enlarge the diameter of the work at this point.

Metal rested directly on metal and hammered will get larger or stretch. Fix this firmly in your mind. In making a bowl of this kind you are driving the metal up and in, not stretching it. Holding the work correctly is no small part of the art of raising.

After you have hammered all around the circle of the base, hammer around and around the bowl, changing its position on the stake slightly for each blow. The hammer marks will overlap as you

(Continued on page 108)

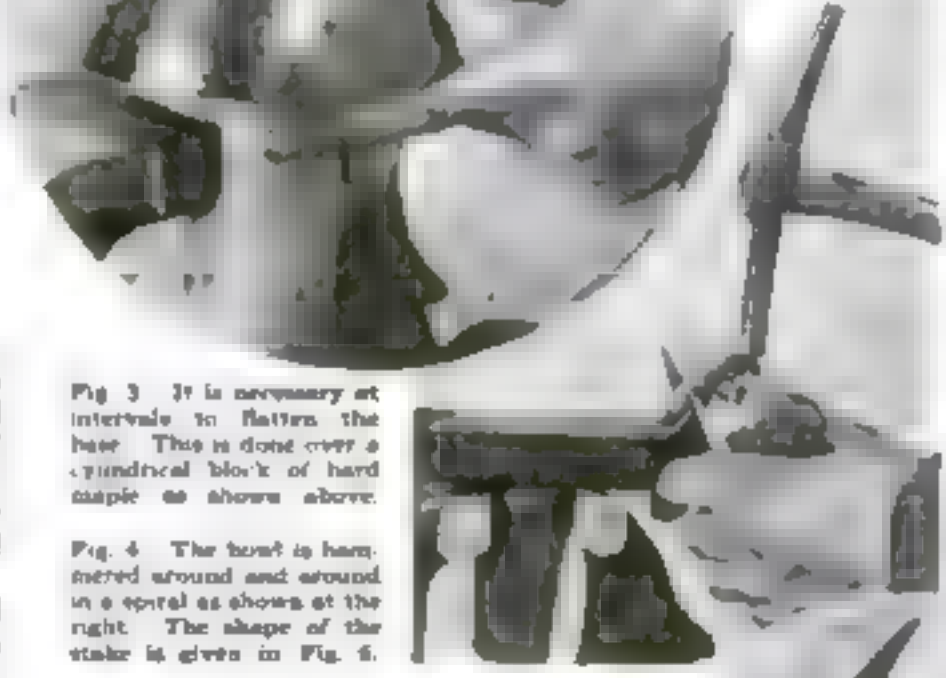


Fig. 3. It is necessary at intervals to flatten the base. This is done over a cylindrical block of hard maple as shown above.

Fig. 4. The bowl is hammered around and around in a spiral as shown at the right. The shape of the stake is given in Fig. 6.

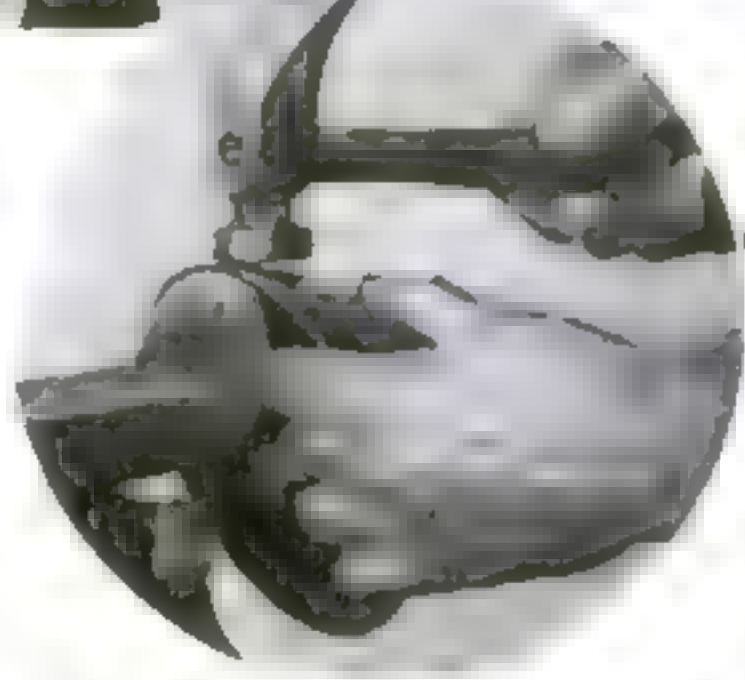


Fig. 5. To take out the marks of the raising process, the bowl is hammered with a planishing hammer.

How to Use Your Hack Saws

Told by the Foremost Makers of Metal-Cutting Saws

IN this age of metals, Disston maintains its leadership with metal-cutting saws of amazing efficiency. Saws made of Disston Steel, from Disston's own steel furnaces. This great cutting steel has edge-holding qualities that only Disston's 89 years' experience as saw makers and as steel makers can put into steel.

Disston makes not only metal-cutting circular saws from ½ inch to 90 inches in diameter, and machine hack saw blades of Disston High-Speed Steel, but also hack saw blades *for your use*, in your hand frame.

Ask for "Disston" Hand Saws, of course; but also Disston Hack Saw Blades for your home workshop.

A Disston Hack Saw Frame for All-Around Use

Disston No. 58 ½ Hack Saw Frame takes all blades from 8 to 12" long. Six wing nuts are provided for saw tight at right or sideways. Hand hole large and comfortable. Frame 90 to.

Files for the Metal Worker

Disston makes all kinds, sizes and styles of files for every purpose. A Disston 8-inch Mill File, bastard cut is fine for sharpening saws, lawn mowers, garden tools, and general work in the home and shop. Excellent for finishing metal surfaces. 45 cents each.

Handiest of All Small Saws

The Hack Saw, with fine teeth and stiff back, enables you to accurately cut a variety of metals, grooves, etc., for making furniture, picture frames, etc. Disston No. 4 12" saw, 8" spoke back, 14-point, costs $2.00.

USE Disston blades which cut easier and stay sharp longer. Blades with 18 teeth to inch (regular), are best for general use; those with 24 teeth (medium), are best for cutting 16- to 20-gauge sheet metal or tubing, brass or copper, and those with 32 teeth (fine), are best for cutting thinner tubing and sheet metal.

Strain blade *tightly* in frame. Cut slowly—not more than 60 strokes per minute for best results. Put pressure on forward stroke, lift slightly on return stroke. Make each stroke do its work. Cut straight, do not bend blade. Bending, looseness of blade, and sawing thin metal with teeth too coarse for the job, all result in broken blades.

Disston Hack Saw Blades are made of Disston Steel. The teeth are milled at a special angle, to give them the greatest cutting speed and durability. Every third tooth is a "cleaner" tooth, to carry chips out of the cut and save the cutting edges.

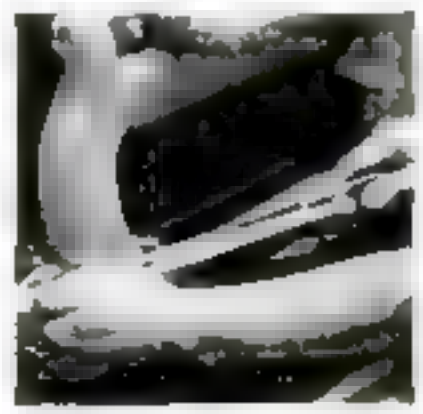
Disston regular *All-Hard* (Chromed) Blades are suitable for general use. Disston *Flexible* (Duraflex) Blades are preferred where cutting is done in awkward positions, or in unstable material, such as flexible conduit, or where there is danger of breaking All-Hard blades.

Disston All-Hard or Flexible Hack Saw Blades,
8-inch 60c doz., 10-inch, 65c doz., 12-inch 75c doz.

Good hardware merchants everywhere sell Disston Hack Saw Blades and Disston Hack Saw Frames.

DISSTON

Makers of "THE SAW MOST CARPENTERS USE"



A Disston Hack Saw Frame for Use in Close Quarters

Disston No. 600 Hack Saw Frame enables you to cut where wide frames can't get in. Only 1 inch from tooth edge to inside of back. Takes 8" blades. Frame, 70 cents.

For Cutting Soft Metals

You can use a Disston Metal-Slitting Saw on your power outfit. Cuts sheet brass, and copper, etc. Disston makes the most efficient metal cutting circular saws of all types. Write for information and prices on Disston Metal Cutting Saws for any purpose.

"The Saw Most Carpenters Use"

The two handiest saws for the home workshop are the 26-inch 8-point for cross-cutting, and the 26-inch 5½-point for ripping. You will need these on almost every job. The popular "D-8" Lightweights cost $2.45.

Every saw user will enjoy reading "The Disston Saw, Tool and File Book," an illustrated manual on the selection, care and use of tools. It tells how to file and set saws and contains much other helpful information. Sent free. Use the coupon, or write for it.

Henry Disston & Sons, Inc., Philadelphia, U. S. A.
(In Canada, address Henry Disston & Sons, Ltd., Toronto)
Please send me "The Disston Saw, Tool and File Book."

Name and Address

"Which *Weld* Shall I Use?"

Old Bill Explains the Differences Between Three Principal Methods of Knitting Metal Together

By JAMES ELLIS

Old Bill found a heated controversy under way between two of the older apprentices as to how the broken casting should be welded.

RETURNING from lunch a quarter of an hour before whistle time, Old Bill went through the office into the shop to see how the welding of a large casting was progressing. Two of his welders were working straight through the noon hour to finish the job without a stop. He found several of the shop's crew gathered near by watching and was glad to see that they were far enough away from the intense light.

Apparently an argument was in progress. Two of the older apprentices were almost on the point of blows. He heard one of them say, "Wait until the boss comes in, and I'll prove it by him!"

When Old Bill joined the group, this boy exclaimed to his coworker, "Now we'll see who's right!" He turned to Old Bill and spluttered heatedly, "Jack says that this casting should have been welded with the new electric welder that we have, and I told him that this was the best way."

Jack was taken aback and plainly embarrassed because of this implied criticism on his part of the boss's judgment but he said, "It seemed to me that if we used the electric welder it would not have been necessary to heat the casting, the fuel would have been saved, and the job finished in less time." He paused for breath. "I remember when I worked for Kelly's Garage that several times they repaired cracked water jackets with the electric welder without removing them from the car."

JACK, having stated his case, glared at his buddy belligerently.

"But I told him that this job was far too heavy for that scheme," was the instant retort.

"Well, you seem to have done some thinking about welding, anyway," Old Bill diplomatically commented as he looked about the group. It was apparent that older men also had been taking part in the discussion and were just as interested as the boys in the outcome of the dispute. "I don't doubt that cracked water jackets can be repaired with the electric welder to better advantage than any other way," Old Bill continued as he leaned against a convenient bench, "but a large and heavy casting is another matter.

"Consider this casting that is being welded now. It is a heavy machine frame and must be strong enough to carry a considerable load. All told, there are about sixteen inches of welded joint at the place where it broke, which takes quite a time to put in. There are several pounds of metal to be added.

"Now in the case just mentioned of the cylinder jacket, all that is required is a little bit of metal on the surface to hold about two pounds water pressure. The heat applied when it is electrically welded would not cause any appreciable warming of the whole casting, so the expansion problem does not exist. No particular stress is on the weld, so it can safely be of another metal. All of you realize that steel is deposited from a metal electrode."

"Suppose you were to use a carbon electrode on the casting?" Jack asked.

"In that case we would be doing just about what we are doing with the acetylene torch. The carbon electrode only supplies heat to melt a metal filler rod. The troubles from expansion would be the same," Old Bill explained.

He passed on to observe the work more closely for a moment and returned to the group to find that there was still an animated discussion of the subject of welding. He listened until he was again appealed to for a decision on another welding question.

"Now that we have several methods of welding at our disposal," he said, "we have to study the different jobs and decide which is really the better way of welding a part.

"The oldest form of welding is the kind that the blacksmith does at his forge. It will always be best for some work, or at least until the defects of gas and electric welding are removed.

THE blacksmith takes advantage of the fact that steel and wrought iron do not melt suddenly, but pass through a plastic stage in which they are neither solid nor liquid, having some of the properties of both. A commonplace example is wax. You have sometimes softened a piece of wax so that you could shape it into any form. You found you could beat it at a point where it wasn't actually melted yet was more plastic than when cold. Wrought iron is somewhat the same. Now, cast iron and brass and, in fact, most cast metals, are more like solder, which, as you know, melts with a very small temperature rise—there isn't so much of an in-between period.

"When our blacksmith wants to weld a shaft together, he prepares, or scarfs, the ends to a certain shape that he has found will be about right. Then he heats both pieces to the point where they are neither solid nor melted, but are plastic and sticky. It may be that on the surface there is a film of molten metal, but that is not essential. The flux he puts on is not to melt the metal, but to melt the scale that forms, and also to make a film that prevents air from causing more scale to form when it comes in contact with the hot metal. When the (Continued on page 110)

THEY ALL DEPEND ON STARRETT ACCURACY

You like to do a job right. That's why you'll get a real "kick" out of owning and using Starrett Tools, the tools that are known and accepted the world over as the standard for accuracy.

Your dealer sells Starrett Tools. It pays to look for "Starrett" or "The L. S. Starrett Co." on every tool you buy.

Let us mail you a free copy of the Starrett Catalog No. 24 "W" containing full descriptions, illustrations and prices of over 2500 tools, tapes and hack saws.

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World's Greatest Toolmakers
Manufacturers of Hacksaws Unexcelled
Steel Tapes—Standard for Accuracy
ATHOL, MASS., U. S. A.

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3103

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Simplified Angular Set-Ups

Short Cuts in Solving an Often Troublesome Shop Problem—How to Get Along without Trigonometry

By HENRY SIMON

THE easiest way to hold machine shop work at an angle is by the use of a universal vise. But the trouble is that this way often will not do when we need it most.

Many times there is not room enough for the vise on table or faceplate. Or where the work is large and the operation is heavy, it may not be possible to get a proper grip in any vise. With small angles that must be accurate, it is often more convenient or better in all ways to use some other means of holding. Finally, there may be the good old reason that the expensive universal holding fixture is conspicuous by its absence. It is well, therefore, to be prepared for such occurrences by lining up a few simple ways and means in advance.

Angular holding without graduated angular scales frequently requires determining the angle by calculation. With small angles on moderate-sized work, trigonometry can be replaced as a rule by plain "figuring." Merely by impressing Fig. 1 on your mind and remembering the number .0174 as the sine of 1°, you can instantly figure the "height" (to use a very incorrect though handy expression) of any angle between 0 and 10° with reasonable accuracy. All that is then necessary is to multiply or divide as shown, to determine the height *H* required for the angle, or to find the angle *A* when you know *H* and the length *L*. In this manner, you will eventually save many irritating delays and time spent in consulting trigonometrical tables, while results will be amply accurate for most purposes, as may be seen from the table

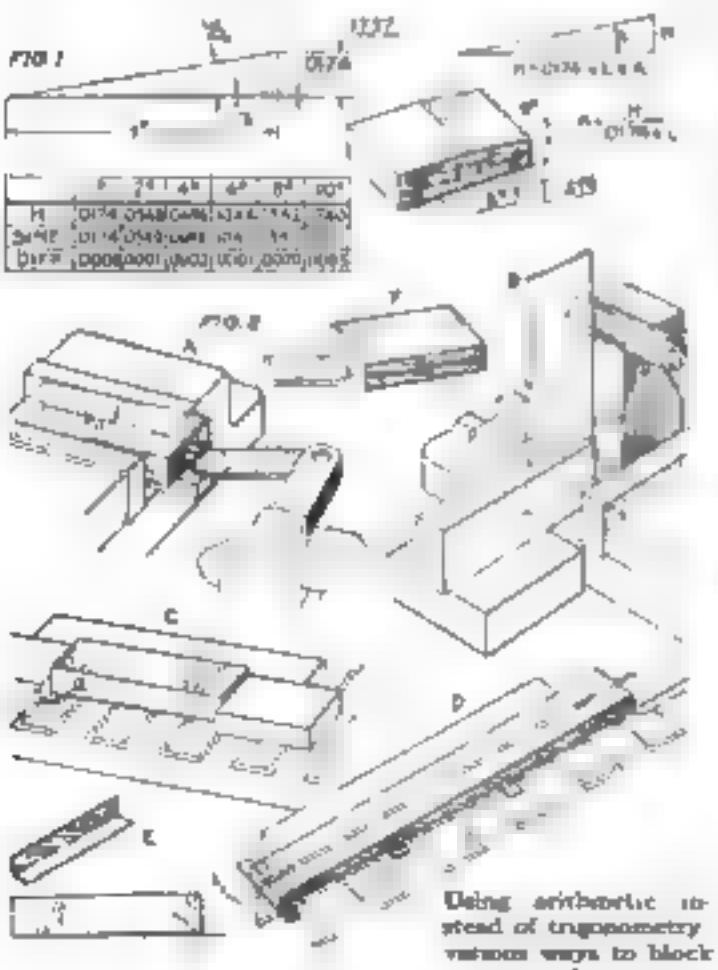
Using a feeler gage to set a block at an angle in the vise. Mr. Simon gives an easy way to calculate the correct height.

Figure 2 illustrates one out of many opportunities for applying this trick of memory, though the main purpose is to suggest ways of blocking and holding work having small angles. At *A* is seen the quick way of setting a block out of parallel by a few minutes or degrees in a vise by the use of a feeler gage. How the same block may be set by the same procedure in an upright position is shown at *B*. To adapt the method to the magnetic chuck on the grinder as at *C*, a narrow strip of sheet metal is used as a "block."

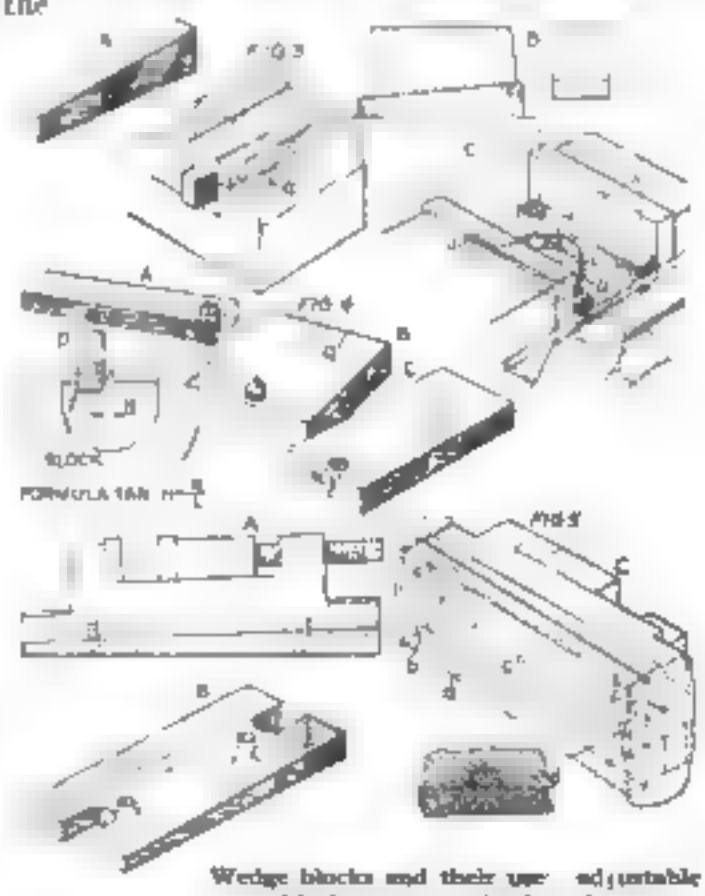
How long and slender work can be readily held at a small angle is demonstrated at *D*, Fig. 2. The long wedge is blocked at several points by strips of sheet metal or shim stock, placed in position by sliding them against a straightedge as indicated. A good variation of the procedure, suitable especially for very thin "blocking," is pictured at *E*. In all cases it must be remembered that *L* is not the length of the work, but the length from the contact edge of the work to the near or contact edge of the block or gage, as indicated at *F*

For very accurate work which must be duplicated, it is often best to have some one-way, set-angle device. A simple and obvious expedient is the wedge block for use in the vise, shown at *A* in Fig. 3. It must be kept in mind, however, that any shifting of such a block out of parallel with the vise jaws will produce an error in the angle, and the use of a spring "spreader" *B* is therefore advisable. In using two such blocks spaced apart, as at *C*, great care must be taken that both are properly aligned, or the piece will be cut as at *B*. The best way to avoid this is to make the angle blocks exactly alike all over, and then line up their ends with the side of the vise as indicated in the illustration, while a spreader keeps them in firm contact with the jaw surfaces.

A handy device and one almost less trouble to make than a fixed-angle block is the adjustable "sine block," of which different types (Continued on page 120)

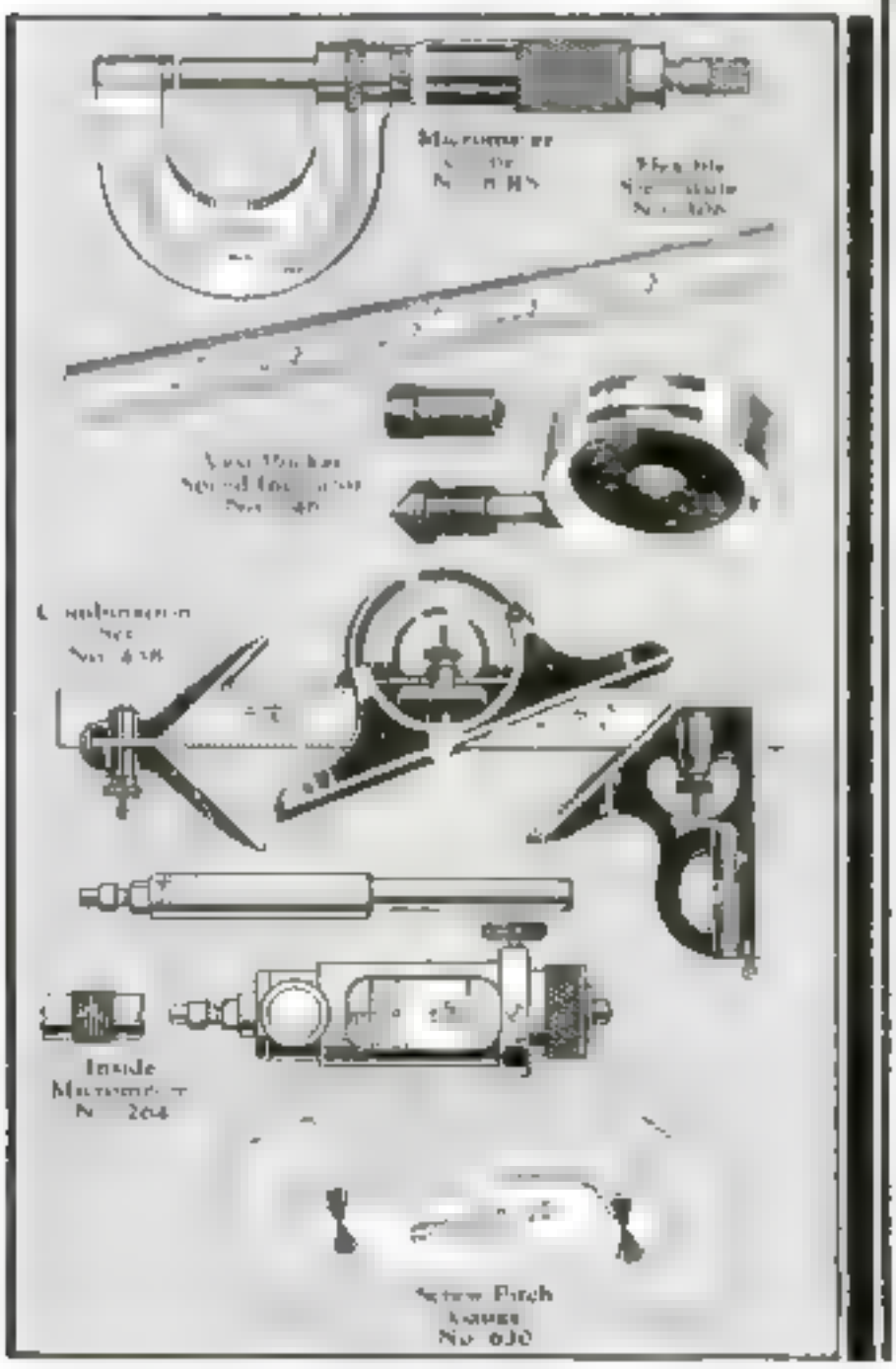


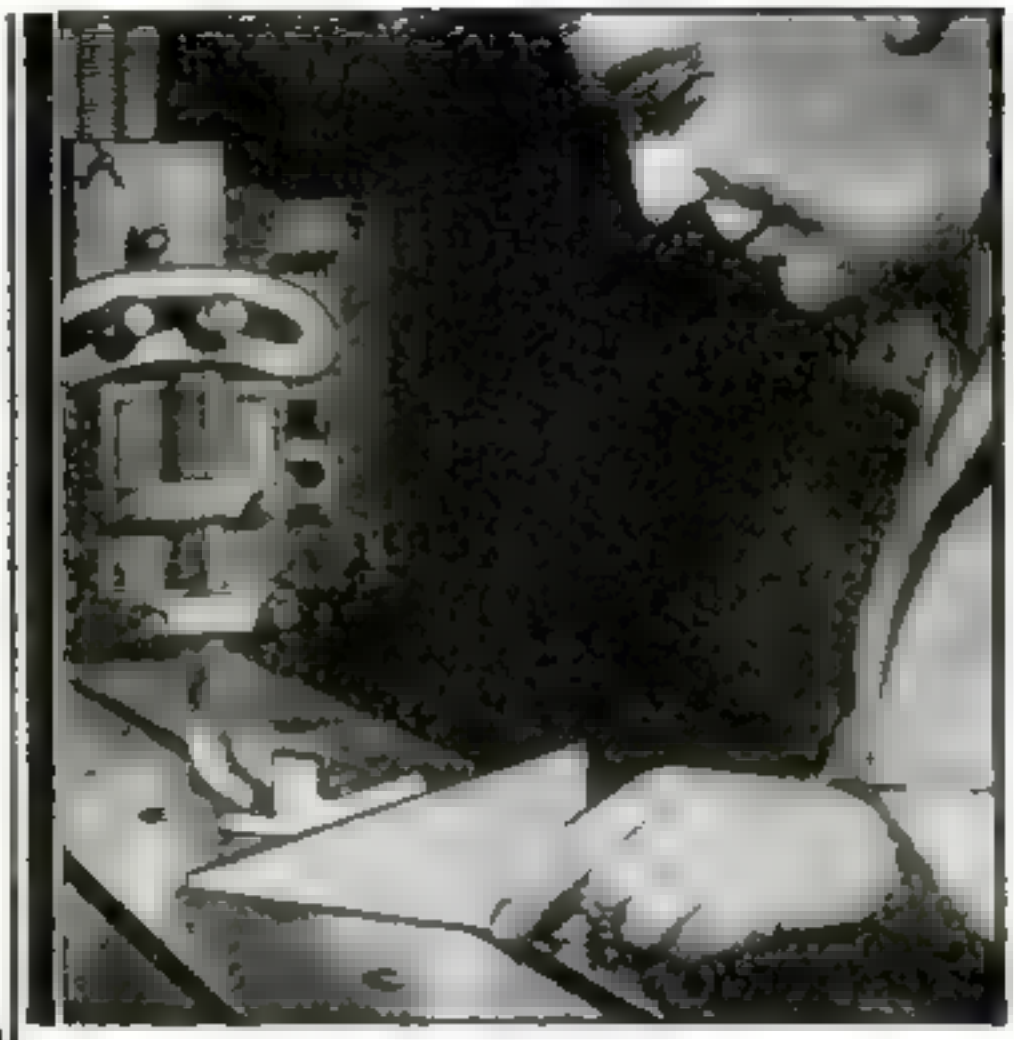
Using arithmetic instead of trigonometry various ways to block up angular work



Wedge blocks and their use; adjustable sine blocks; an angular base for a vise

Keeping Pace With The Greater Demands *for* Accuracy





WITH production schedules calling for greater output and, at the same time, standards of inspection becoming more rigid, the use of fine precision tools in industry becomes more important. Mistakes mean confusion all along the line.

It is with a recognition of this dependence on fine tools that more and more skilled mechanics and manufacturers are turning to Brown & Sharpe Tools. They know that the standard of accuracy maintained in Brown & Sharpe Tools is their greatest safeguard for accurate work.

The Brown & Sharpe Planer and Shaper Gauge No. 625 shown above is an exceptionally convenient tool for setting up cutting tools quickly and accurately. It is but one of over 2300 tools described in the new Small Tool Catalog No. 31. Your hardware dealer will be glad to give you a copy or you can get one from us. Address Dept. P. S., Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

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"WORLD'S STANDARD OF ACCURACY"

BROWN & SHARPE TOOLS

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

"Let's Play Grocery Store"

Although it is stocked with cans and packages and has a weighing scale that works, the materials for this toy store cost only $1.

By ROBERT HAROLD GADE

As a birthday present for my daughter, I built the play store illustrated. It is stocked with cans and containers just like a regular store and has a realistic weighing scale, yet the whole cost was less than one dollar for materials.

The store is set in a corner of the yard, the fence forming one side and the back, although it was removed and rearranged temporarily for the purpose of taking a clearer photograph.

The shelves are in sections so they can be removed indoors in bad weather. Each section consists of two uprights 1 by 4 in. by 4 ft. 6 in., four shelves 1 by 4 in. by 3 ft., and two crosspieces in the back 1 by 4 in. by 3 ft. 1½ in.

The top of the counter is 1½ by 12 in. by 3 ft., but a 1 in. thick board would do as well. The two sidepieces that support the counter are 1 by 12 in. by 2 ft. There is a shelf under the counter and boards to inclose the front of the counter case.

The framework in front is 5 ft. high. The roof is made from burlap sacks, as is also the one exposed side when the store is set up in the fence corner. At a slightly higher cost it would be possible to use wall board instead of burlap.

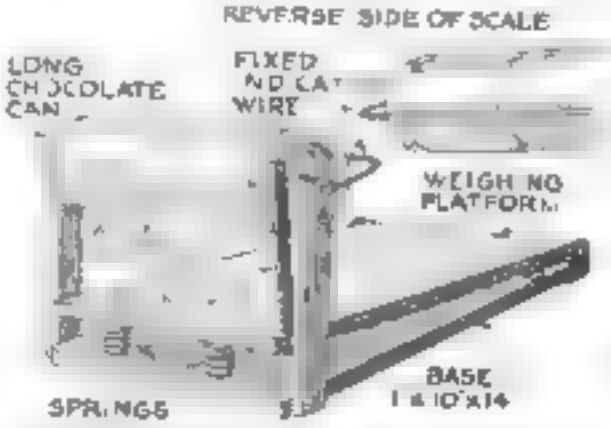
The main feature of the store is its stock. This is provided by soaking the labels from all cans before opening them (so that the labels will not be damaged in the process) and using a fifteen-cent can opener of a type that leaves smooth, turned in edges all around. If you cannot obtain such a can opener, hammer the edges smooth.

When a stock of cans has been prepared, paste the labels on again. If you wish to make an extra fine job, use shellac instead of paste and then give the whole can and label a coat.

Save all butter, gelatin, and other cartons. Provide sand to represent sugar, flour, and the like. Your grocer will let you have some counter advertisements.

The scale is a chocolate can with the top soldered in place and a paper scale pasted on the surface. The base is 1 by 10 by 14 in., the uprights 1 by 2½ by 10 in., and the weighing platform 1 by 8 by 13 in. The platform and drum are connected with a scrap strip of brass. The hinges can be made as shown from two pieces of metal ½ by ½ by 2½ in., or a pair of small hinges may be purchased. Two small coil springs placed under the weighing platform cause the scale to return to zero.

Two scoops from the ten-cent store complete the equipment. The woodwork should be painted brightly. An awning or sign may be made from shelf oilcloth or an old awning.



How the weighing scale is constructed. The drum turns when the platform is depressed.

The above views show the five plants in which Nash Cars are built. Their great factories are located at Kenosha, Racine and Milwaukee, Wisconsin

* * *

JOHNS-MANVILLE products serve industry and home owners in many ways. J-M Asbestos Shingles protect and beautify the home. J-M Improved Asbestocel helps to keep it warm. J-M Brake Lining makes motoring safer for millions of car owners. J-M Acoustical Treatment conserves the nervous energy and speeds the work of millions in office buildings and industries. Throughout the manufacturing world, J-M Packings, insulations and fireproof materials are famed for economy and conservation of life and property. Look for the "J-M" trade-mark—the hall-mark of quality of an established manufacturing authority.

Fireproof Roofs for Five Great Factories

THE leading motor car builders of this country have established a world-wide reputation for efficiency in every phase of operation. Nash Motors is another of these great industrial establishments to protect its huge investment in buildings with roofs provided by Johns-Manville. The five great factories in which Nash cars are built are roofed with Johns-Manville roofs of three types selected for the purpose from more than twenty distinct types of J-M Roofing.

The Nash Buildings are chiefly covered with Johns-Manville Asbestos Roofs of which 800,000 square feet have been used. This is a smooth top roof, free of gravel or slag surfacing. It is made of many layers of fireproof J-M Asbestos Felt and J-M Asphalt Roofing Cement. The performance of this type of J-M Roof is bonded by the National Surety Company. The length of the guarantee may be 20, 15 or 10 years as desired, depending on the type of J-M Roof selected.

Let an Expert Help you to Choose

There is a J-M Roof for every purpose and every type of construction. The superlative roof is unquestionably the J-M Built-up Asbestos Roof—a fireproof, smooth-topped roof which will withstand every variety of weather. There are also J-M gravel topped roofs for those who prefer this type of roof protection.

Johns-Manville Roof Experts are men trained in the roofing business. A J-M expert is available without cost or obligation to help you in selecting the right roof for your buildings. Since Johns-Manville sells all varieties of roofs the J-M representative is in a position to give you genuinely unbiased advice.

J-M Roofs Applied only by Approved Roofers

Nor does J-M service end with advice. When the right roof has been chosen a Johns-Manville Inspector checks every detail during application, and afterward makes regular inspections throughout the life of the roof. And as far as application is concerned J-M Built-up Roofs are applied only by approved roofing contractors whose ability and reliability plus adherence to our rigid application specifications qualify them for the J-M franchise.

We invite you to use the convenient coupon, or write us for a copy of our new booklet. "Johns-Manville Bonded Built-up Asbestos Roofs."

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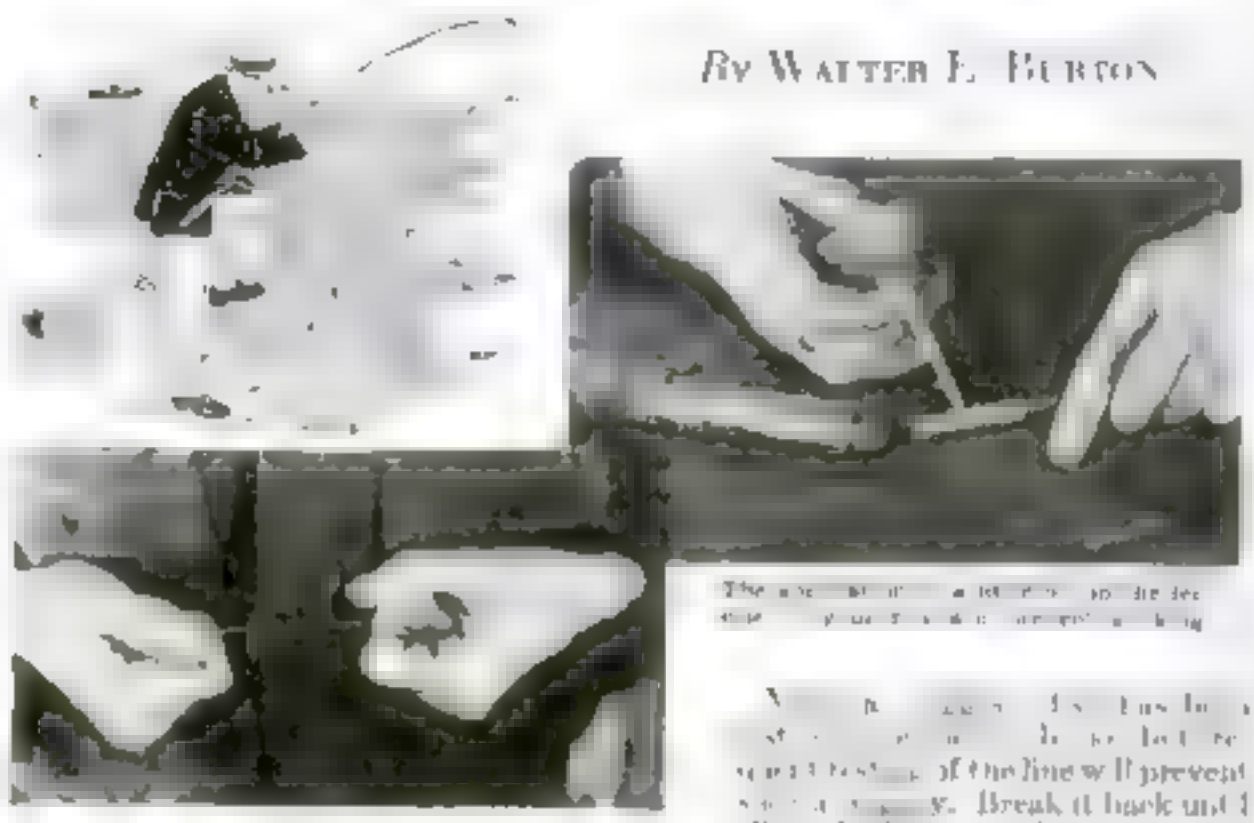
Ways to Catch More Fish

An Expert Angler's Hints on the Care and Use of Your Rod, Reel, and Line

By Walter E. Burton

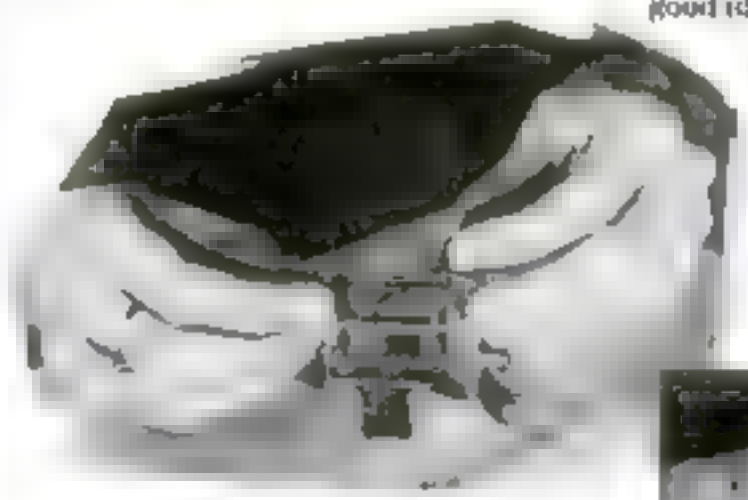


Test a line frequently by trying to break it or by using some more rigorous test. Remove any weak parts.

OF ALL the little kinks and stunts that every fisherman should know in order to get the greatest joy out of his sport, the following suggestions are considered the most helpful by an angler who has been designing fishing equipment for the past half century. They should be remembered by every member of the fishing fraternity.

In putting the rod together or taking it apart never twist it, and in handling it keep all strain off the guides. A little oil or grease on the ferrules will prevent their sticking. Wooden or cane rods should be given a coating of flexible varnish when they show wear. At the conclusion of a season's fishing, hang your assembled rod on a hook by the tip guide, and tie a weight on the butt so that all kinks and bends will be removed for the next season.

The reel is as important as the rod. No reel, old or new, should be used without first being oiled and greased thoroughly. Frequent lubricating is essential—all points twice a day, and some oftener.



Your reel cannot be accidentally lost overboard if you make sure the line is tied firmly to it.

Now [illegible] of the line will prevent [illegible]. Break it back and [illegible] all weak places are eliminated. Always test line, leaders, and snells before fishing.

The best way to cure a twisted or kinky line is to let it out behind a boat at full speed. The action of the water will work out the kinks. Always tie the line firmly to the axle of your reel so that if the reel becomes loosened from the rod and falls into the water, it can be recovered. At the end of the day's fishing, stretch out all the used line to dry overnight.

Essential tools for the tackle box include cutting nippers, round-nose pliers, flat-nose pliers, large and small screw drivers, small scissors, a smooth-cut half-round file, oil can, folding pocket rule, thirty-pound capacity spring scale, and an awl. A stick of ferrule cement and a spool of No. 2 0 silk thread for mending broken rods can be added. It is also a good idea to have on hand a soft rag and polishing paste for spoons and spinners.

Before using silkworm or gut leaders, soak them for at least twenty minutes in water to take out the brittleness.

Sharpen fishhooks with a fine file or an abrasive stone. If a hook is (Continued on page 122)

Set of tools suitable for making all necessary emergency repairs to fishing tackle on a trip.

Correct Time is in your Light Socket --*Use It!*

YOUR local electric company is supplying a new service to your home—correct observatory time by electricity. This service is coming to you now, whether you are using it or not. All you need, to obtain absolutely correct time, every hour of the day and night, is to plug the Kenmore Electric Clock into your light socket.

No Winding—No Regulating Always Absolutely Accurate

Kenmore Electric Clocks are operated by the frequency alternations of alternating current. They are equipped with a synchronous cycle motor that revolves in unvarying synchronization with your electric current. Once set to correct time, your Kenmore cannot vary—it is absolutely accurate even to the second. Kenmore Electric Clocks have no springs, pendulums or escapements. They never have to be wound or regulated. For are Electric Time is a new method of timekeeping that for the first time assures absolutely accuracy.

Sixteen Handsome Models, Some for Only $15

Dealers the country over are showing sixteen handsome models of Kenmore Electric Clocks—mantel clocks, bracket desk sets and kitchen clocks. Many are in shiny bakelite in beautiful colors. Priced as low as $15.00 they offer a model for every purpose or purse.

Beautiful Booklet — FREE!

A beautiful booklet showing all models in full color has just been issued. A copy will be sent free if you will write

THE KODEL ELECTRIC & MFG. CO.,
500 E. Pearl Street, Cincinnati, Ohio

Kenmore
ELECTRIC CLOCKS

"The Clocks That Can't Be Wrong"

Time by Electricity for the Modern Home

How the Modern Kenmore Electric Clocks utilize ordinary house current to give absolutely correct Naval Observatory Time.

The Kenmore synchronous cycle motor "counts" the cycles in your house electric current, and records them as seconds, minutes, and hours.

WHETHER you know it or not, whether you use it or not, your house electric current is now carrying correct Naval Observatory Time into your home.

Central power stations in practically every city in the country have installed automatic synchronizing equipment to supply electric time service to the home.

Electric time in the home is the latest, and probably the most unique use to which electricity has ever been put. It is a highly practical use because it offers to the home the desirable convenience of absolutely correct Naval Observatory Time, without the constant variations in time of the old spring wound clocks, and in addition furnishes relief from clock winding, oiling, and regulating.

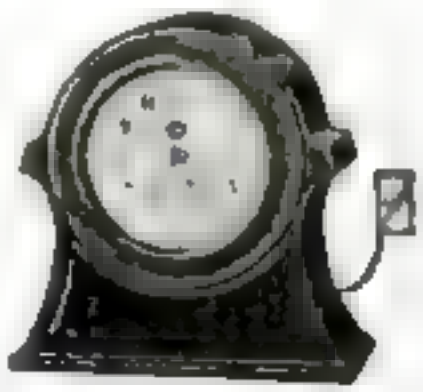
The electric clock of the Kenmore type is constructed so that its movement is synchronized with the frequency of the house electric current. Instead of the springs, escapements, pendulums and other mechanism of the ordinary clock, the Kenmore electric clock contains a small synchronous cycle motor, which "counts" the cycles in ordinary house current, and thus records the passing of seconds, minutes and hours.

In order to insure absolute accuracy of electric time, electric power stations synchronize the frequency of the current to correspond accurately with Official Naval Observatory Time, which is sent out by radio each hour from Washington. This is checked periodically each day to see that the frequency of the current is kept absolutely correct. The power station charges nothing for this service, except for the small amount of electricity the clock consumes.

The Kenmore electric clock resembles the ordinary spring wound clock only in appearance. It has none of the mechanism of the usual clock. Even the familiar "tick" is missing. The Kenmore electric clock never has to be wound, oiled, or regulated. You simply plug it into the light socket and forget it.

Sixteen models of the Kenmore electric clock have been developed and are now offered by dealers all over the country. Some are in the conventional design of present day clocks, others in bright glossy bakelite in a myriad of shades and colors. They are priced as low as $15. The cycle motor in all models is exactly identical, so that no matter what price you pay, you get the very same accuracy.

The many models of Kenmore electric clocks have been elaborately illustrated and described in a new booklet recently issued. In this booklet, all models are illustrated in full colors, with a complete description of how synchronous current is used. This booklet is offered free and can be obtained by writing The Kodel Electric & Manufacturing Company, Electric Clock Division, Cincinnati, Ohio.



Two models of the Kenmore Electric Clock. The model on the right, priced at only $15, is offered in bakelite cases in twelve different color combinations. The model on the left is of dark Mahogany or Walnut. Both are illustrated in full colors in the booklet referred to above.

Cards *That* Rise *by* Magic

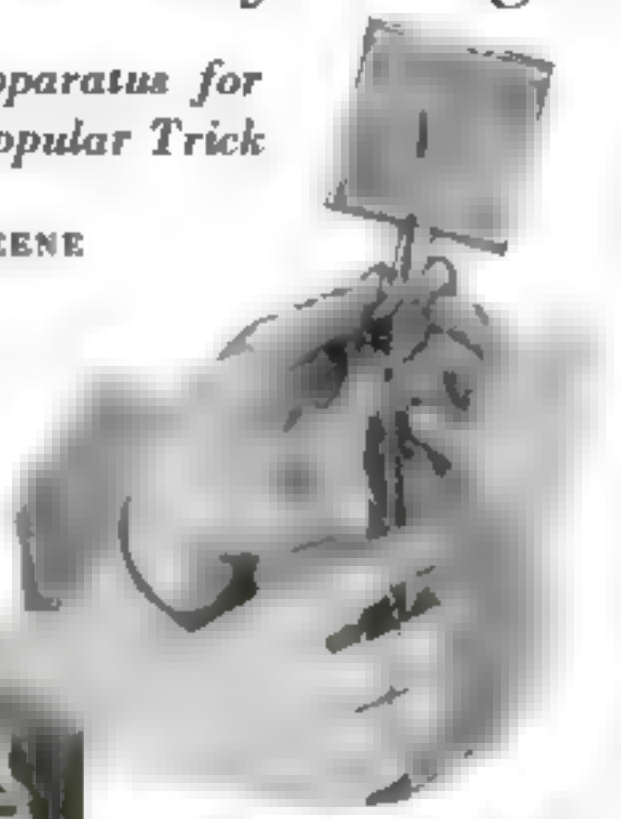
How to Construct New Apparatus for Performing an Old and Popular Trick

By GEORGE S. GREENE

THE trick of causing cards to rise from a deck usually requires a duplicate deck interwound with threads. With the unique apparatus to be described, any unprepared deck may be used and shuffled immediately before the trick.

The performer places the deck in a transparent celluloid case resting on a stand on the stage or platform. A spectator is offered a small rifle, revolver, or cap pistol (loaded with a blank), and instructed to fire at the deck. He misses and smashes a glass vase on a table at the other side of the stage, causing considerable laughter. Then the performer fires the pistol, and thereafter one card at a time slowly rises from the deck at his command.

A transparent container for the deck of cards is made from sheet celluloid, the ends being fastened with strong film cement.



Assembling the card holder stand, and mechanism for causing cards to rise.

The stand for the celluloid case is made of a 12-in. length of ½-in. iron pipe, with a base—a floor flange is satisfactory—attached.

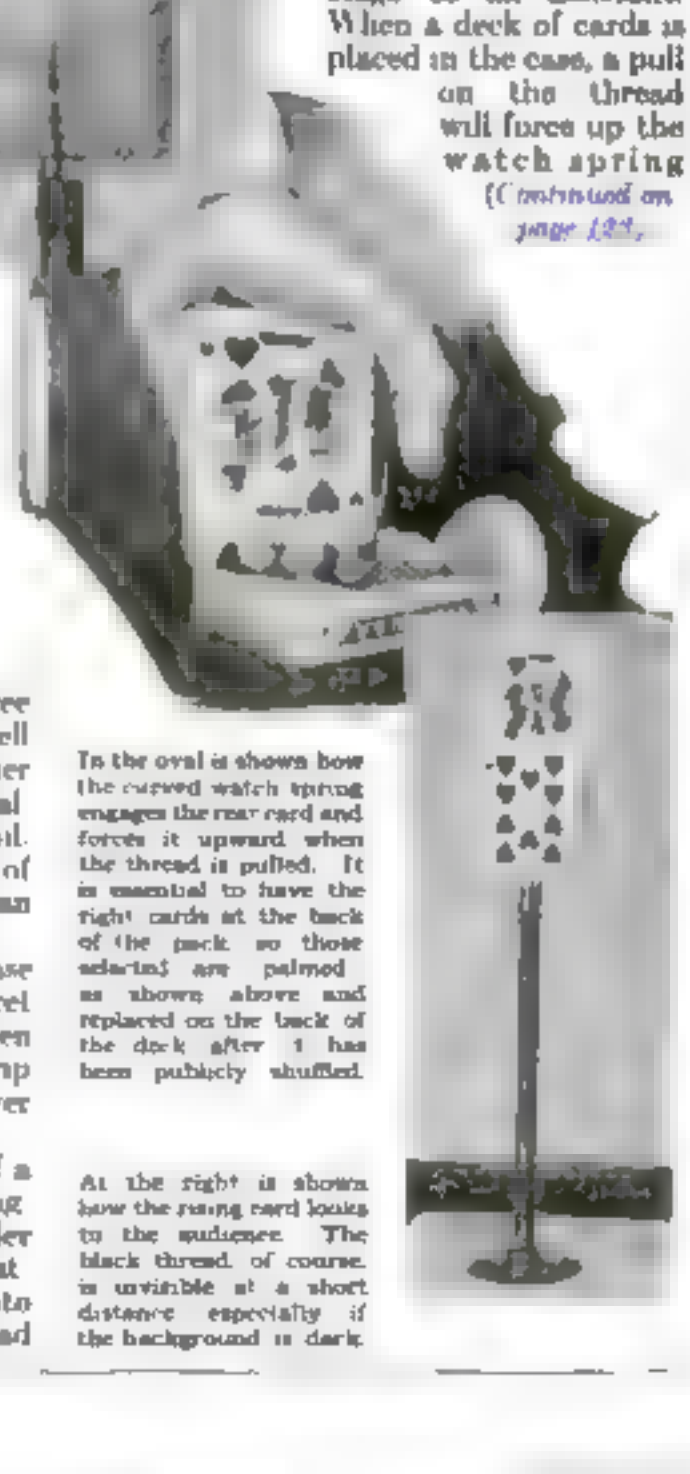
You can buy the celluloid or remove the emulsion from some heavy film negatives by soaking them in hot water. Cut it into two sheets 1 in. wider than the deck and three quarters as long. Bend in the sides as well as the bottom and cement all together with 1-in. strips of the same material. Ordinary film cement (ether, banana oil, acetic acid, and a small quantity of celluloid) can be purchased or you can have a druggist prepare it.

In the center of the bottom of the case make a slit ½ in. long for the secret mechanism to pass through. Then cement to the bottom a celluloid strip formed into a tube of a size to slip over the ½-in. pipe.

The operating mechanism consists of a piece of watch spring about 4 in. long. One end is weighted with a tiny cylinder of lead, to which a black thread is attached. The mechanism is inserted into the pipe, weight down, and the thread brought up through a tiny hole in the celluloid tube that connects the case with the pipe. The end of the watch spring passes up through the slit in the case.

The thread leads off-stage to an assistant. When a deck of cards is placed in the case, a pull on the thread will force up the watch spring

(Continued on page 124)



In the oval is shown how the curved watch spring engages the rear card and forces it upward when the thread is pulled. It is essential to have the right cards at the back of the pack, so those selected are palmed as shown above and replaced on the back of the deck after it has been publicly shuffled.

At the right is shown how the rising card looks to the audience. The black thread, of course, is invisible at a short distance, especially if the background is dark.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Three Poses on One Film

With a surprisingly simple and cheap homemade triplicator you can make trick photographs like this one, which shows the same woman apparently doing three things at one time.

How to Make a Triplicating Device for Your Camera from a Small Round Tin Lid

By CHLOE H. NULL

IN THE illustration above the subject apparently is doing three things at once. This photograph was made possible by a triplicating device made from the tin lid of a vaseline jar.

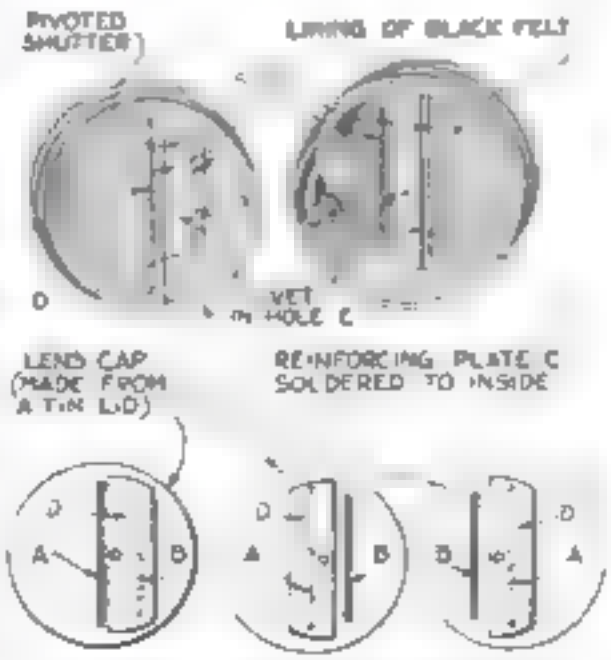
A lid 1⅞ in. in diameter was the size necessary to fit over the barrel of the lens of the camera used. A line was drawn across the exact center of the lid, which was then carefully filed until a thread like slot appeared. A second and similar opening was made ⅜ in. from this slot. These are marked respectively *A* and *B* in the diagram below. The next step was to reinforce the strip of metal between the two slots by soldering to the underside a narrow strip of tin cut as at *C*.

The shutter, cut from tin in the shape outlined at *D*, was riveted to the lid, small holes being drilled at *E* through which the rivet was passed. The whole contrivance was then painted black, inside and out, after which a narrow strip of black felt was glued inside the rim of the lid to make it fit as closely as possible over the barrel of the lens.

After the camera had been placed on a tripod and focused on the chairs and table that were to appear in the picture, the lid or triplicator, as it may now be called, was placed over the lens with the slots running vertically. The tin shutter was turned to expose slot *B* and the end pictures were taken with the regular shutter, the triplicator being given a half turn between exposures. Then the triplicator shutter was turned to expose slot *A*, and the middle picture was taken.

Because of the small amount of light admitted through the slots, each exposure was given three and a half seconds, the lens being stopped down to f/4.

A smaller or larger triplicator could be made in the same manner as the one described, as long as the distance between slots is properly proportioned to the whole size.



Front and rear of the triplicator and positions of the shutter for taking the three views.

Neat Metal Tags Made from Tobacco Cans

AFTER making some changes in the piping around the boiler and engine of an excavator during a temporary cessation of work I marked the valves clearly to correspond to some written explanations with tags made as shown by pushing the bottoms from empty tobacco cans. To fasten the tags to the respective valve handles, I used the wires which had formed the hinge part of the tobacco covers.—F B

Tin tag marked with aid of nail or punch.

Give Your Plane *the Paper Test . .*

THEN TRY IT ON A MILLERS FALLS

HOW many times have you wondered why planes so often slipped and chattered and left uneven surfaces on hard or cross-grained lumber? The paper test will answer the question, for to completely avoid chattering, the cutter must be clamped firmly against the frog for the *full length* of the seat. Try this easy test on your own plane.

First remove the top lever cap and cutter. Then place a thin piece of paper on the frog just above the side of the plane so that the paper extends out over the side. Replace the cutter and lever cap. If you can move the paper easily it shows that the cutter is not clamped firmly enough on the seat, that your plane will chatter on a hard job.

1. Remove the top lever cap and the cutter

2. Place a thin piece of paper on the frog just above the side of the plane so that the paper extends out over the side.

3. Replace the cutter and lever cap.

Now try the test on a Millers Falls Plane or, if you prefer, on your own plane with a Millers Falls lever cap. You will find that you cannot pull the paper out. The three-point bearing of the lever cap, an exclusive Millers Falls feature, exerts a uniform pressure on the cutter the full length of the seat.

Ask your dealer to show you the Millers Falls Planes. Or write us if you want a catalog showing the complete line. There is no charge.

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MILLERS FALLS, Massachusetts

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This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Hammering Sheet Metal Bowls

(*Continued from page 92*)

hammer in a spiral from the base to the outer edge of the bowl. As you approach this outer edge during the first hammering of the surface, the edges will tend to wrinkle or flute up. Hammer out these flutes at once; leave the work on the stake, but use a wooden mallet in place of the hammer as in Fig. 2. Then continue the work with the raising hammer.

After the first hammering over, your bowl will have a slight saucer shape as at *B* in the lower right-hand drawing of Fig. 7. It must now be annealed, pickled, and scrubbed bright and clean before hammering again. Scribe a new base circle. You will probably need to true up or flatten the base. I find that a cylindrical block of hard maple, cut square across the top, is an excellent support for flattening (Fig. 3).

Start hammering again on the same stake and in the same position; continue in a spiral of overlapping hammer marks from the edge of the base out to the edge of the bowl, then anneal, pickle, and scrub, and again lightly scribe a fresh base circle before hammering over the surface again.

Always select and use a stake the surface of which conforms to the surface you

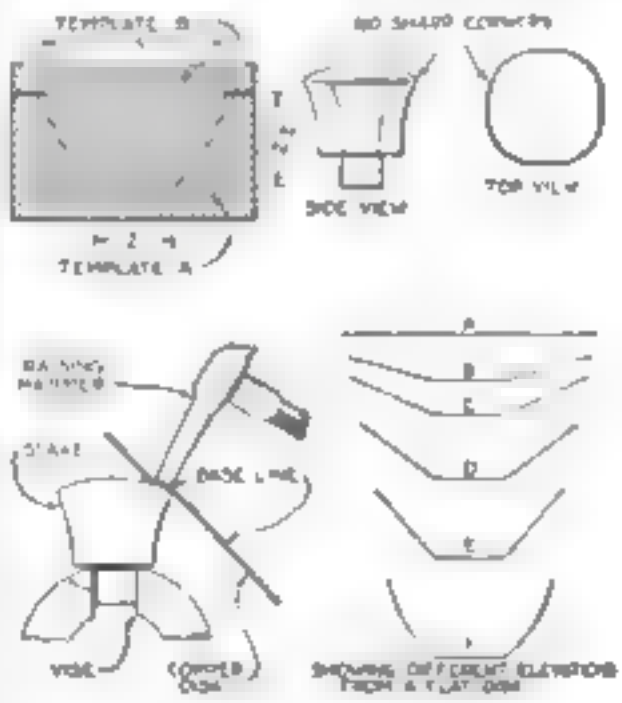

Fig. 7. Template, first stake, position of disk and hammer, and the bowl at various stages.

are hammering at the time. Change these stakes as you find you need a new or differently shaped surface to hammer on. Unless you have the proper stake under your work, you cannot succeed.

In a simple bowl of this kind the whole process may be done on two stakes. A more intricate form may take a number of different shapes and sizes. Experience at the bench will give you a knowledge of the proper stake to use. The second stake used for this simple bowl is shown in Fig. 6.

You really save much time by frequently annealing your work. Besides, it is well to remember that when copper, brass, silver, or gold are beaten too much without softening them, they will crack under the hammer. Any cold "shuts" or folds that form in the metal should be

Fig. 6. Second of the two stakes needed for raising a bowl of the shape shown in Fig. 7.

flattened out at once. As the bowl gets more cup shaped (Fig. 4), the work will go more slowly.

When you have hammered your bowl to your liking, anneal it again, pickle and scrub it very bright and clean, and dry it. Then place it on the stake and take up your planishing hammer, which has a flat face, or one only slightly domed. Hold the metal slightly above the stake surface; that is, a part of the work is rested on the stake and tilted up slightly from it where the hammer hits it (Fig. 5). This is necessary to prevent the planishing from enlarging the bowl.

If the marks left by the raising hammer are very deep, you may have to go over the surface of your bowl two or three times to planish the first marks out. The surface of the planishing hammer should be very highly polished, and your work, when finished, should be covered with beautiful glistening facets. The surface of the stake, too, should be highly polished, for it acts on the inside of the bowl. Unless you have a heavy, power-driven polishing head, you can file the faces of the stakes and hammers with a smooth file and then polish them off with emery cloth.

Usually the last thing done to a bowl is to trim off the upper edge and smooth it up. The bowl is set on a flat surface and a surface gage is used to scribe a line around it where it is to be trimmed off, as illustrated in the May issue, page 79.

The next installment in this series, which is scheduled for early publication, will tell how a high vase form—one turned in at the top—is raised and planished.

WALL papers can be obtained which are an excellent imitation of plastic wall paint with an artistically blended or mottled finish. They are hung like ordinary wall papers except that it is usually necessary to trim an inch or more from the edge and to reverse every other strip from top to bottom. When wall paper is hung on painted walls, there is danger that the paste will make the paint peel unless a coat of strong size has been applied. The size applied over painted walls needs to have more adhesive in it than ordinary size.

MAKING A SOUND PICTURE
with Western Electric Equipment

SILENCE in the studio! The director discards his megaphone, cameras whir in sound-proof booths.

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(Photographs courtesy of Paramount)

Western Electric builds special microphones for studio requirements.

The "monitor" controls quality and volume of all sound recorded.

Western Electric-made apparatus insures true-tone reproduction.

Theatre loud speakers, product of acoustical experts and craftsmen.

The projector which plays the sound picture in the theatre.

Western Electric

THE VOICE OF ACTION

SOUND SYSTEM

Sewing Cabinets Made by Machine

(Continued from page 80)

curved edges. A smooth f[illegible]

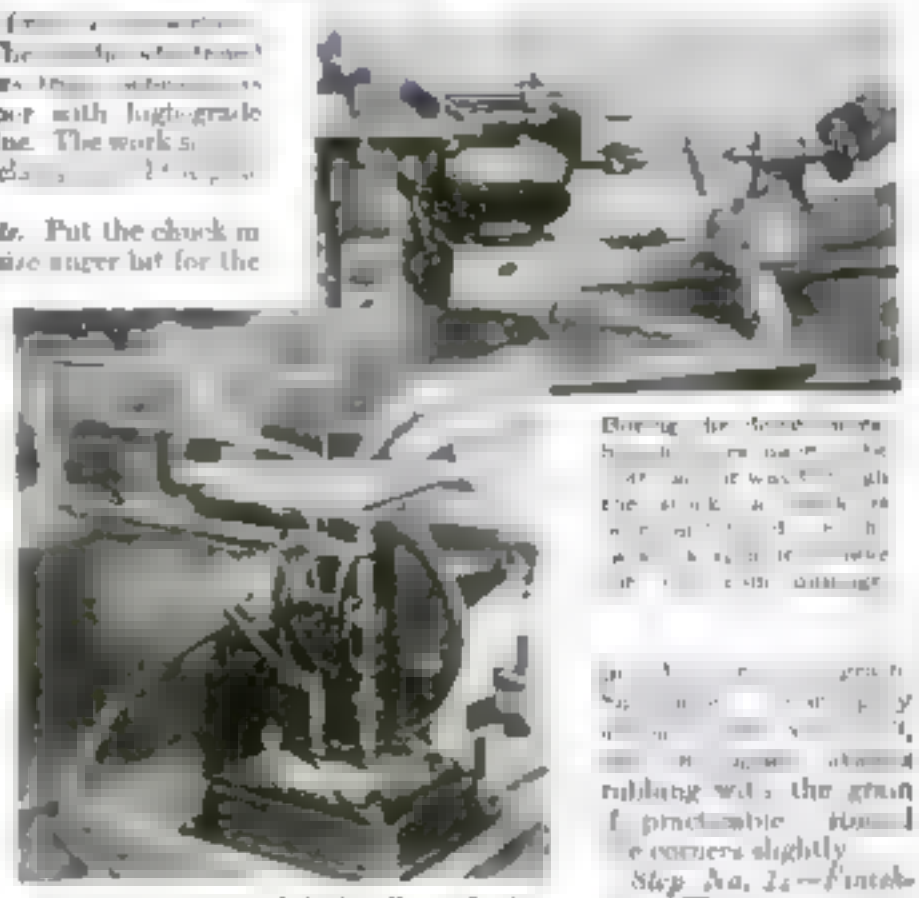
Step No. 6—Assembly. The [illegible] to the top strip by screws [illegible] indicated. Glue the hopper with high-grade liquid glue or flake hide glue. The work s[illegible] be allowed to set between cl[illegible] is hard.

Step No. 7—Dowel Joints. Put the chuck in the lathe, use the correct size auger bit for the dowels (in this case ¼ in.) and, while the power is on, very carefully file the threads off the screw end to prevent the bit from pulling into the wood too fast; do not, however, remove the point. Locate accurately all centers of all holes and bore the holes in the lathe as illustrated. Make sure by careful test that the ¾ by 2¾ in. cross brace is exactly the right length to suit the length of the hopper.

Step No. 8—Assembly. Glue the legs and curved feet first, then glue the cross brace. When dry, the entire bottom unit is fastened to the hopper with screws. Glue a false strip over the center of the hopper to make the leg appear as if it continued all the way up. Next screw the bottom in place and fit the covers and hinges.

Step No. 9—Tray. On the various machines, work out the tray in the same way as the other parts.

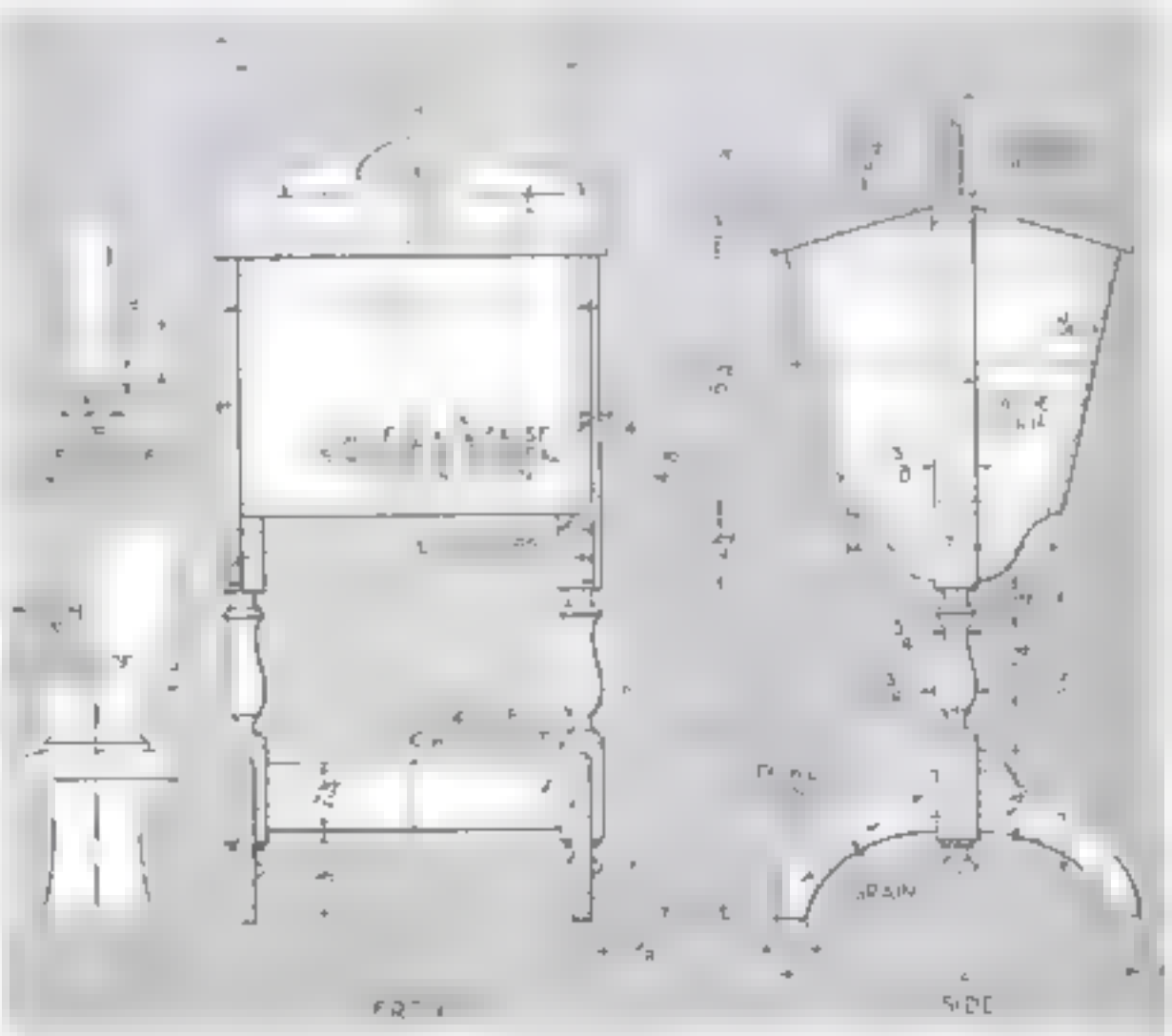
Step No. 10—Cleaning up. Remove all excess glue with a sharp chisel, cutting where



Cutting the inside of the handle on the jig saw is like guiding a sewing machine

[illegible] rubbing with the grain [illegible] practicable [illegible] corners slightly.

Step No. 11—Finishing. There are many ways of finishing mahogany. One was described last month. Another requires the use of bichromate of potash, which can be purchased at any drug store. Make a saturated solution of the crystals and water and apply a coat of one part saturated solution and four parts of water. When dry sandpaper lightly with No. 00 paper then give a coat of ready-mixed penetrating mahogany stain. Follow with paste wood filler and finish with several coats of shellac, varnish, or clear lacquer.



Assembly views of the Priscilla cabinet and details of the joints at the corners of the hopper and between the legs and end pieces. Make cardboard patterns to aid in marking the curved parts.

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Old Bill *Says*—

WHEN a hole is to be drilled with reasonable accuracy on a drill press, start it with a pilot drill in a small center-punch mark rather than with the final drill in a large center-punch mark.

Be sure that the size is correct on the tools the crib attendant gives you. Because he makes a mistake is no reason you should.

To get the most service from milling cutters, it is absolutely essential that they be ground accurately.

Always use the side heads on planers and boring mills for taking side cuts whenever possible.

Rubbing a little chalk on taper shanks of drills seems to keep them from working loose. If they are worn badly, a bit of newspaper will make them tight.

Clamping bolts and nuts last twice as long if the threads are case-hardened.

The cost of making a new bronze bushing will supply oil to the ordinary machine for six months.

"Which *Weld* Shall I Use?"

(Continued from page 94)

pieces reach the right temperature, he places them in contact and applies pressure to force the surface of one into the surface of the other, just as you can join two pieces of wax when they are heated about right. When the actual welding is done, the blacksmith hammers the shaft into the shape desired."

Old Bill paused while the one-o'clock whistle blew.

"FORGE welding has its place," he went on. "Pipe is made that way. It is the only kind of welding that can be used for certain kinds of chemical equipment, for the reason that the entire vessel must be of precisely the same material. You see, in forge welding, nothing is added. All of the material is in the original stock. This is also true of electric butt welding and of spot welding, but not of the kind of welding that our machine turns out." The group nodded assent.

"The next kind of welding to come along was gas welding—just what we are doing over there. It was found that acetylene, when burned with oxygen, would produce such an intense heat that cast iron would melt, much as a candle does when a match is put below it. Those of you who have used the torch know that all you do is to melt a pool of the casting being welded and feed into that pool the new metal from a welding rod. You use a flux to do away with slag, which otherwise would be mixed with the weld and cause weakness.

"Almost all cast metals as well as steel and wrought iron can be welded with the torch. It must be remembered always, though, that the weld is of different composition chemically from the base metal. Some close approaches have been made, but there is always a difference. And another point to remember is that the weld is always a casting, and is not as strong as a rolled or forged piece of metal."

Old Bill stuck a match to his old pipe.

"Because heat is applied over such a small area and because, of necessity, there must be much more heat than is actually required to melt the metals, expansion and contraction give trouble. One way to avoid the trouble is to heat the entire casting to somewhere near the temperature of the weld. This is what we have done over there now.

"The newest kind of welding to be applied generally is the electric arc method. We have recently put in a machine, and you have seen some of its work. It is most useful for welding steel and is making some very marked economies because it has given us a new and dependable way of putting steel parts together. By the use of the arc welder we are not limited to the shapes that can be rolled or forged, but can put plates and bars together in almost any way. It is a much nicer method than the blacksmith's forge, for it does not heat any part of the work except the small spot where the metal is being deposited. It differs from gas welding in that the welding rod is projected in a molten state across a space where an electric arc is passing. The arc heats the spot where the metal will go and at the same time melts the rod. No flux is required. No heat is wasted in heating the mass of the metal, hence parts can be welded with little distortion, although there is some."

OLD BILL'S group was intensely interested in what he was saying, and several men had joined his audience.

"Now then, with these methods of welding at our disposal," Old Bill proceeded, "we can do many things that we could only wish to do twenty years ago. Ordinarily, I should say that any piece that could be forge-welded should be. Any casting except steel should be welded with acetylene, and all steel parts should be electrically welded.

"Of course, there are exceptions to this," he hastened to add. "The cracked cylinder is an example. We may find that to braze, or bronze-weld, steel parts will be best in a certain case. Or a bulky forged ring that the blacksmith might handle if he had to can often be done best with the electric arc."

Are You Really Well Informed?

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Like an Old-fashioned Examination

May we ask you to make this test carefully, reading the questions slowly and giving thought to each one? When you cannot answer one satisfactorily to yourself, put a zero (0) beside it.

On the other hand, give yourself credit of four (4) for each satisfactory answer. Then when you are through, see how near you have come to making a mark of 100.

This is like an old-fashioned examination, but you will find it fascinating. The questions all have to do with the wonders of the world we live in. All can be given quick and straightforward answers by any person of education.

All of the questions in the famous "Popular Science Questionnaire" and many hundreds of others, have now been answered, for the first time, in one book—THE POCKET GUIDE TO SCIENCE.

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Test Yourself Now

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2. Are the stars solid like the earth? ____
3. How was the earth formed? ____
4. Why is glass transparent? ____
5. How do we know that the earth is slowly shrinking? ____
6. What is an electric current? ____
7. How was petroleum formed? ____
8. Do electrons really move through wire when an electric current is flowing through it? ____
9. What physical changes in your body are produced by fear? ____
10. How do muscles exert power? ____
11. What are X-rays? ____
12. Can we see atoms with a microscope? ____
13. Why does heat expand things and cold contract them? ____
14. Why does the moon appear to change its shape from time to time? ____
15. What is the brain made of? ____
16. Why is it possible that the inside of the earth is growing hotter instead of colder? ____
17. Why is it not more likely on a clear night than on a cloudy one? ____
18. Does thinking use up the thinker's energy? ____
19. Which travels faster, electricity or light? ____
20. What simple test will distinguish wool from cotton? ____
21. What makes the noise of thunder? ____
22. Why would men ultimately suffocate if all the green plants were killed? ____
23. Does the boiling of water remove the impurities in it? ____
24. How do the living cells of the body get the energy with which to do their work? ____
25. How is the speed of light measured? ____

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How to Repair Your Lawn Mower

Paste this Home Workshop Reference Sheet, including the head above, in your scrapbook in the section marked *garden*. (September, 1929, POPULAR SCIENCE MONTHLY.)

How should one choose a new lawn mower?

FOR those who want a small, lightweight, low cost mower for use on lawns of small area, steep grades, rough surfaces, and terraces, there is the mower of 14-in. width, 35-lb. weight, having 8-in. wheels and three blades on the rotating cutter assembly. This machine is especially suited for persons unable to manage a larger machine. The larger machines, of 20-in. width, 65-lb. weight, with 10-in. wheels and five or six rotating cutter blades, are best for large areas of level, smooth lawn. Between these are machines of intermediate sizes, usually made in widths of 14, 16, and 18 in. The larger machines are misjudged as being worn out, before such is the case, more often than are the smaller machines.

When a mower has been used for a season or two and has become increasingly hard to operate despite efforts to adjust the blades for wear as well as copious applications of lubricating oil, what should be done?

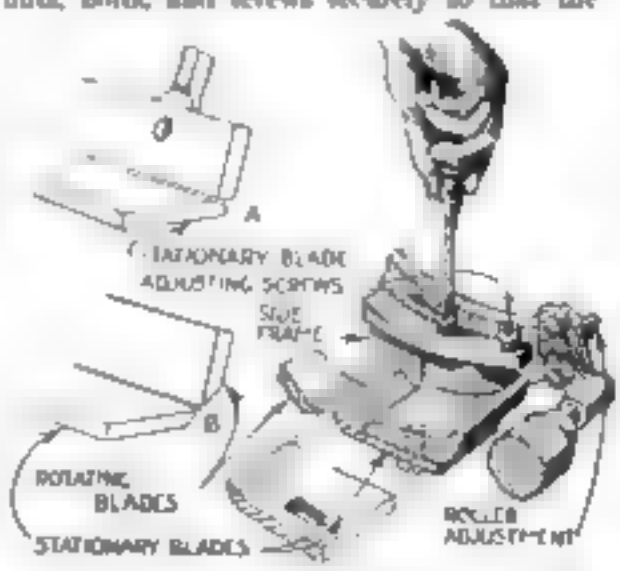
1. REMOVE wheels and cover plates, clean grass and all other parts, and examine for wear.

2. Obtain any necessary renewal parts, such as gears or ratchet pawls, from the dealer or manufacturer. Replace all parts which are badly worn. Turn the rotating blade assembly by hand and check closely to see that it has not been bent in use. If the spindle has been bent, it will be necessary to dismantle the mower completely before it can be straightened. In case this has to be done, the rotating blades, before being again assembled, should be ground or filed as outlined farther on.

3. Reassemble and oil parts. Tighten all nuts, bolts, and screws securely so that the frame and shrub bar will hold the rotary cutter blades and the stationary cutter rigidly.

4. Adjust the spindle bearings of the rotating cutter assembly to within close limits—loose enough to allow the spindle to turn freely yet close enough to eliminate sidewise or up-and-down movement of the spindle in the bearings.

The cheaper machines are usually equipped with plain sleeve bearings without adjustment. If worn excessively these bearings should be replaced. Other machines having sleeve type bearings are provided with adjustment by means of split bearings, set screws, and other means. Most good mowers are equipped with ball bearings which need no adjustment, while still others have adjustment provided for this type also. *Regardless of the type of bearing employed all lost motion can be eliminated.*



How friction is caused (A) and the remedy (B) the way to regulate the stationary cutter

5. Next adjust the stationary blade so that it makes tight contact with the rotating blades. It may be necessary to bend or spring the stationary blade so that it will make contact over its full length. This can be done by adjusting a monkey wrench so that the cutter blade will just pass between the wrench jaws. The wrench is then used to bend the blade.

6. We now come to that part of the overhauling most often overlooked even by good mechanics. After a mower has been in service for a certain period, the clearance between the stationary blade and the revolving blades increases because of wear until the mower no longer shears the grass off cleanly. The stationary blade is then adjusted upward until proper contact is made between the blades. This adjustment is made as often as is necessary to correct the condition or until such a time as the mower becomes increasingly hard to operate. Because the effort necessary to operate the mower has increased so gradually as to arouse no suspicion of its cause, it is easy to assume that the condition responsible for ninety-five percent of the increased friction has always existed. Close analysis shows that this is a false assumption.

The sketch at *A* shows the condition of the stationary blades at the point of contact or shear after long use. Gradually increasing contact area between the blades has increased the friction until one could hardly be censured for thinking that the mower is worn out. *Obviously the thing to do is to relieve the blades so that the contact area is reduced to the minimum required for successful operation of the machine.* This usually can be done Continued on page 115

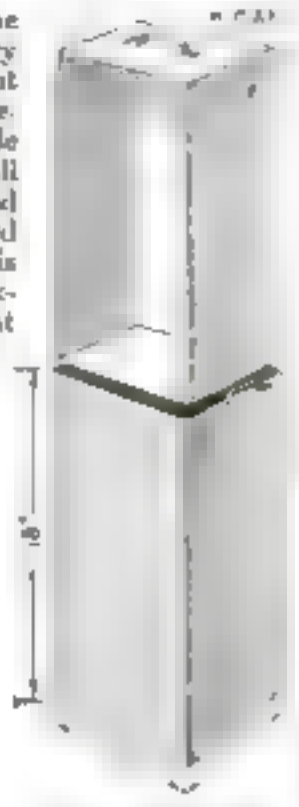
By careful sharpening and adjustment many old lawn mowers can be made to cut like new

Telescoping Water Cans for Auto Campers

IN AUTO camping the main thing is to carry the essential equipment in the least possible space. I have a compact double container for all the small tinware, knives, forks and spoons, coffee pot, canned goods, and the like; it is also used to carry drinking water and to heat water for dishes.

The outer part *A* is a can of heavy rustproof tin, made to fit into one end of the car trunk. All seams are soldered, and handles are applied near the top (shown), the carrying strap. Into this can fits that marked *B*. In camp the outer can, which holds a little more than 5 gals. of water, is used for drinking water, the inner one as a cook pan.

EDWARD C. TOOP.



One can fits snugly within the other

Lawn Mower Repairs

(Continued from page 112)

by the use of a fine mill file. All the blades should be filed off as shown at *B*. It is possible to do the filing without dismantling the machine; however, should the blades prove so hard as to resist the action of the file, it will be necessary to dismantle the machine and grind the blades. Filing or grinding should be done very carefully and a part of the old contact marking, between ⅛ and ¼ in. wide, should remain visible on the blades. If the markings are removed by accident, the stationary blade can be moved upward until contact is made between it and the rotating blades, when a few minutes operation of the mower will show clearly where additional filing is required.

7. If an exceptionally fine job is desired the blades should be adjusted for operation, the mower turned upside down, and a little grinding compound, such as is used to grind automobile valves, placed on the stationary blade. The abrasive should be so placed that the addition of a few drops of oil will float it between the blades at the point of contact or shear.

Operate the mower in the upside down position until the blades are lapped or ground sufficiently to give full length contact. Very little grinding of this kind will be found necessary unless the blades have been badly abused. Care should be exercised to prevent any of the abrasive compound from entering the spindle bearings. Sections of the blade which show too much contact area after grinding should be filed off as previously directed.

The blade adjustment should be just close enough to shear newspaper.

8. Give the mower a good surface of weatherproof paint. It should, of course, be thoroughly cleaned of all dirt, rust, oil, or loose paint before repainting. Roller adjustment should be made to suit the lawn surface conditions and to give the desired length of grass.

To keep a mower operating with the least attention, it is necessary to wipe it clean and dry after use. Rust probably causes more damage to the blades than does wear due to service. A good opportunity to recondition the lawn mower comes at the end of the season or in the winter when time can be taken to do the work most thoroughly.—A. R. ALLARD.

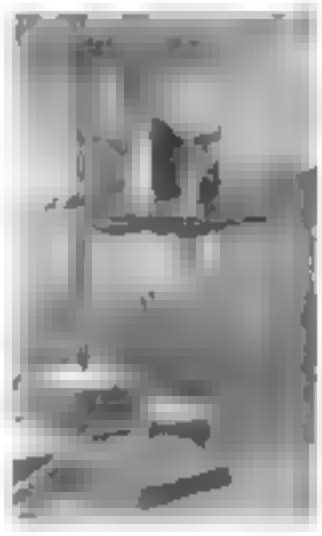
Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

GLASS stoppered bottles sometimes are difficult to open. If the handle of the stopper is flat, hold the bottle in the right hand and place the flat of the stopper against the table or bench. With the left hand, press a piece of wood about a foot long against the stopper and the table or bench. Twist the bottle backwards and forwards in a circular motion with the right hand. This will usually loosen the stopper.

When the head of a glass stopper is round, other methods must be tried. A string twisted once about the neck and rapidly drawn back and forth will heat the neck so that it will expand slightly and probably allow the stopper to be removed with little effort.

If the last method does not work, the neck may be slightly heated over a Bunsen burner or an alcohol flame, provided the bottle does not contain any inflammable liquids. Keep turning the neck while holding it in the flame for a second or two. Should this method fail, try tapping the stopper with a piece of wood.



Improving corks with melted paraffin.

As a last resort the neck of the bottle must be broken. To accomplish this, it is necessary first to make a file mark all around. Then after wrapping a clean rag about the bottle, hold it perfectly vertical and tap the neck sharply with a small hammer. As a rule the neck will break off cleanly so that the contents of the bottle may be poured off into a new one.

CORKS, when new, should be thoroughly softened before they are used. This can be done by rolling them between two wooden surfaces or by tapping them with a hammer all around.

Corks may be made to fit air-tight by treating them with paraffin. Melt the paraffin in a beaker or pan at a temperature of about 158° C. and throw in the corks, covering them with weighted wire gauze so that they will remain submerged. At the end of ten minutes the corks may be removed. When cold, they may be cut like wax and will fit tightly, at the same time, they will not be easily acted on by acid or alkali.

When making a hole through a cork, bore halfway through from the small end, then bore from the other end to meet the first hole.—ERNEST RADE.

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Awning Frame Supports Vines Over Windows

WINDOWS on the sunny sides of the house can be protected from glare by building a simple awning frame as shown and training vines over it. The foliage is far more attractive than the faded awnings so often seen.

The design can be adapted to single windows, pairs, or groups. For fast-growing annuals such as morning glory and Japanese hop, the framework can be built of 1 by 1 in. and ¾ by 1½ in. strips. For the heavier perennials such

Trellis designed to take the place of awnings in providing cool green shade for sunny windows.

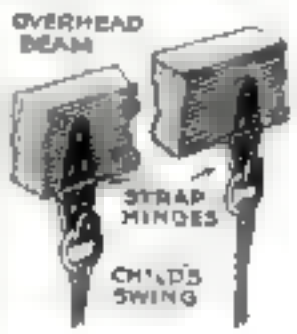
as honeysuckle, however, more substantial framing should be used.

After measurements are taken, the awning frame, minus the uprights, should be completely assembled on the ground and a 2 in. mesh chicken wire stretched over it. When it is nailed to the window frames, drive the nails at an angle so they will secure a good grip.

The vertical uprights, which are set into the earth, also carry chicken wire to help the vines on their upward climb to the canopy.—H. S.

Hinges Support a Swing

HEAVY strap hinges make good bearings for a porch or a basement swing. Bend one leaf of each hinge as shown to form a hook and then screw or bolt the other leaf to the joist or beam from which the swing is to be suspended.



A simple way to hang a swing from a beam.

Keep the hinge joint thoroughly oiled.

Instead of rope, an old sled chain is excellent for suspending the seat. Insert rings in the chain to slip over the hook-like members of the hinge.—R. H. PITT.

Child's Towel Rack Supported by Two Elephant Heads

By EDWARD T. PAYSON

Use to wash

WITH a few odd pieces of lumber and a little paint, a novel and useful accessory for the nursery can be made—a towel rack which may induce even a small boy to wash his face.

First cut out two elephant heads from clear pieces of ¾-in. hardwood. The heads may be made any size by enlarging the construction squares, but a practical size is obtained by reproducing the pattern on ¾-in. squares.

After laying out the figure on the wood, it is best to bore the ½ in. holes marked A before sawing out the head. The dowel rod, which is ½ in. in diameter and the board connecting the two heads can be any length desired.

Paint the elephants gray and use black for outlining the parts of trunk, and eyes. The tusks should be painted white or ivory.

Draw ¾ in. squares to enlarge this pattern.

Driving Glazier's Points

Glazier's mallet with head that slides on glass smoothly

CARPENTERS, glaziers, and others who frequently have to reglaze windows and doors will find a mallet made as illustrated of considerable help in driving glazier's points. The handle should fit rather loosely so that the head will lie flat.

H. W. SWOPE.

What You Can Make of Plywood Cases

By HAROLD P. STRAND

PLYWOOD packing cases are an excellent source of material for the home craftsman. The stock seems mainly to be oak, maple, birch, and poplar. As a rule in the writer's locality the purchase price of a case is from thirty to fifty cents. While the plywood is not made quite as well as regular cabinet stock of this kind, nevertheless careful selection will produce some really good sides that will answer many purposes.

In a kitchen combination table with pot and pan cabinet, which I recently made for a friend, I took advantage of this cheap stock. The top was made from ¾-in. stock glued with 1½-in. square legs, each of which had a groove cut in two sides with a plow plane to receive the plywood sides. These were slid into the

Suspended from the first floor beams in the cellar, this packing case forms a tool cabinet

grooves after glue had been applied. The table was painted a flat gray to match some other pieces in the room, and no one would ever know that the smooth sides came out of packing cases.

The best way to remove the plywood from the frame is to use a fine saw and cut around the frame on the inside, sacrificing the little left on the frame in order to get out the sheet in good shape. In selecting cases at the store, look for sides which are as free from imperfections as possible and those whose grain markings are most pleasing. Let the light fall slantingly on the side under examination and look for smooth surfaces, free from many waves.

In the construction of particular work it is best to use regular cabinet plywood for the exposed surfaces that are to receive a fine polished finish. For the backs, drawer bottoms, partitions, and any less conspicuous sections, the (Continued on page 137)

Casein Glue Fastens Hems of Yacht Model Sails

ALTHOUGH I spent many years as an amateur yachtsman and have sailed practically everything this side of a battleship, I am convinced there is as much "kick" to sailing models as there is in navigating the larger craft. In this connection I should like to offer a suggestion that may save the model yachtsman much tedious sewing. Instead of hemming the sails in the orthodox fashion, I paste over the edges with thick casein glue, using a long brass ruler to keep the edges perfectly straight.

Small sail with glued instead of sewed hems.

Another good stunt is to paste in a looped cord for the vertical edge; indeed, the cord can be run all the way around if desirable. Stretch it barely taut between two pins or nails and before the glue is entirely dry press the ruler down firmly and snugly against the rope on both sides so that the bulge will not appear entirely on one side. It is well to sew the foot and a few inches of the clew on a sewing machine as an added precaution.

Casein glue can be had from some hardware and paint dealers and often from woodworking plants. It does not stain the sails. J. G. PRATT.

Using Plywood Cases

Continued from page 9

cases provide far less expensive plywood.

My first console radio cabinet was made by gluing up mahogany boards to obtain the desired width and then securing the panels to the corner posts with dowels. Never again, now that I have been initiated into the use of plywood. The grooving matcher plane cuts a neat groove in the corner posts, the plywood panels slide in, and what could be simpler?

A few hints on handling plywood: Keep it in a dry place, for although much of it is made with waterproof casein glue it will curve and buckle and the plies may separate if left in a damp place. It is well upon acquiring a plywood case to saw the sides out and lay the sheets flat, one on top of the other, in a warm, dry place, with a few flat boards upon them for weight. Do not attempt to use a warped piece of plywood in a cabinet unless the frame which supports it can be braced to overcome this, which is usually not possible. In sawing plywood place it on a wide, flat surface, like a large, smooth-top box free from nails, and make the start and finish of the cut by cutting into the box as well as the plywood, in such a way as to prevent splintering the plies.

One very good use to which I have put a plywood case is that of making a dust-proof "crib" for my tools and special materials. I hinged the cover of the box to form a door, added a lock, and painted the whole a dark gray to keep out the dampness. This "cabinet" is hung from the floor timbers in my cellar shop.

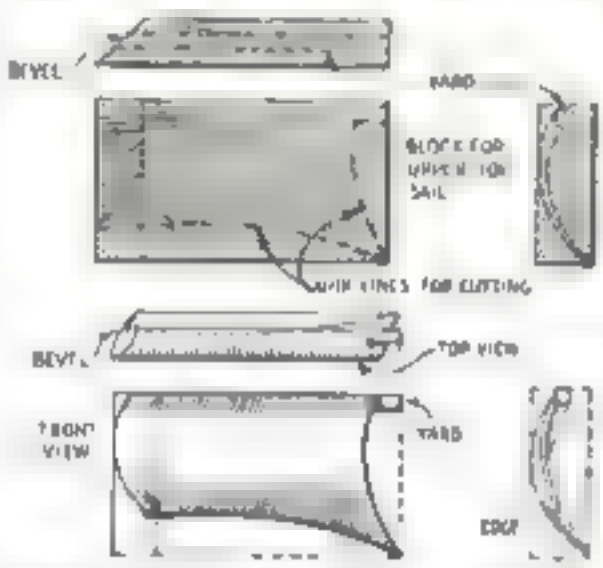
Half a Ship Model

(Continued from page 41)

This is the original model as built by Captain McCann. The color scheme is as described in the article, the sky being blue with white clouds and a tinge of yellow toward the horizon.

do for the blocks. These ropes should be light brown. The reef points and hunt lines are drawn with a pencil on the sails after the wood has been painted a slightly grayed white.

At the main this ship carried the house flag of the Aberdeen White Star Company a white star in a red bal on a blue ground. At the mizzen are the numbers



Sketches to show how one of the square sails is laid out and carved from a piece of wood.

(naval flags) M.L.P.T.; at the gaff, the red English ensign. They are best painted on thin paper.

The sea can be made of putty, gesso, or a plastic wood composition. Note that the "send" of the sea is at nearly right angles to the direction of the wind, which is about parallel to the royal yard.

Ultramarine, with a little green where the waves are high, and white foam are the colors.

Around the case fit a picture molding or other molding having a double rabbet, one to take the glass and the other to fit the front of the case. Weathered oak, green oak, or other dark stain is suitable.

The model with hull, deck fittings, and spars. Note especially the arrangement of the stays.

Ways to Catch More Fish

Continued from page 209

forced into the flesh, do not attempt to pull it out, push it on through so that it comes out as near the place where it entered as possible. Then treat the wound at once with iodine or mercurochrome.

Never string fish through the gills. If the string is passed through both lips, the fish will remain alive longer, but the most humane way is to kill them immediately and cover with moist moss, water grass, or a gunny sack.

Hooks are sharpened with either a file or a small stone or stone

Before putting the undersize fish back, wet the hands. This relieves the danger of infecting the fish with deadly fungus from the dry hands.

Flies and other feathered lures make excellent food for moth larvae. They should be protected with a standard moth preparation.

Water snakes, turtles, and other vermin make a specialty of fish eggs and small fish for food. Such destroyers of multitudes of small fish should be killed.

Sometimes a hooked fish becomes entangled in the grass. It is unwise to pull on the line in an effort to dislodge it, for the line may break. Let the fish alone for a time to dig himself out.

If your line becomes snagged and it is necessary to break it, do not do so by pulling so that a strain is thrown on the reel. Take the line in the hand and manipulate it.

Never bait- or fly-cast with three or more in a boat. Someone is likely to get hooked and painfully hurt.

Fishermen or hunters often desire to preserve an unusual catch. Fish or small game should be sent to a taxidermist entire and well iced, if possible. Otherwise, plenty of salt must be worked into the eyes, mouth, throat and nostrils. Fish can be packed in damp moss or sawdust, with the mouth, gullet, and gills well dusted with salt.

The true sportsman—and every fisherman should be one—posts himself on the fish and game laws of the state or province in which he is fishing, and then observes them. He kills only for sport, and respects size and bag limits.

Homemade Curve Ruler

A strip of lead, a spiral spring, and a length of rubber tubing form this flexible curve ruler

BUILDERS of ship and yacht models, as well as draftsmen who have to draw many large irregular curves, will find particularly useful a curve ruler made as shown from a length of chemist's rubber tubing of $\frac{3}{8}$ in. inside and $\frac{1}{2}$ in. outside diameter, a ten-cent screen door coil spring, and a $\frac{1}{16}$ in. square strip of lead cut from the edge of a piece of sheet lead. The spring should be stretched sufficiently to reduce its stiffness before being inserted in the tubing.—J. G. P.

Cards That Rise by Magic

(Continued from page 103)

A rat trap riveted to a metal tray breaks the glass vase as a shot when a thread is pulled

so that it engages the back of the next card of the deck and causes the card to be projected. This may be repeated with as many cards as desired.

If at the conclusion it is desired to allow the stand to be examined, the thread can be broken off short, whereupon the mechanism will fall to the bottom of the tube.

It is obvious that the rear card of a deck is the one first pushed upward by a pull on the thread. To select any particular cards to be made to rise, palm them on the hand while the deck is being shuffled and add them to the back of the deck before placing it in the card-shooting case.

The illustration above shows how the glass vase may be smashed when the spectator fires the pistol. The vase—of the ten-cent variety with paper flowers—stands on a tin tray, which is deep enough to conceal a strong rat trap riveted to it. The trap has a thread fastened to the release. When the spectator fires, the assistant pulls the thread and releases the trap, which shatters the vase. The tray should be placed on a stand above the eye level of the audience so that the breaking mechanism will not be seen.

Clamping Fruit Jar Caps

HOUSEWIVES sometimes experience trouble in putting up fruits in glass jars of the type illustrated because the cap is not held tightly enough against the rubber ring. This difficulty usually can be remedied by giving the clamp wires a slight offset with a pair of heavy pliers.—A. Hagerstrt.

Screw drivers used for heavy work that requires them to be tapped occasionally with a hammer may be protected from damage by driving a polished steel chair glide on the end of the handle.—C. S.

Reproducing an Old Clock

(Continued from page 68)

for the insertion of the backboard. The front edge is rounded over slightly

The top board of the case and the base are doweled or pinned to the sides, but screws at the top and bottom are better. The top board is also rounded over. The baseboard is made of pine with a molding fastened to the front edge and the ends.

At each corner and at the top is a wooden block 1 by 1 by 1 3/8 in. and in the center is a third piece 1 by 1 by 5 in. Between them is the scroll, made of 1/8-in. mahogany veneer. Under the baseboard are the base scrolls, which are made in three parts of the same material. The corners are mitered and a number of pine blocks or cleats are glued in the angles for additional strength. Cut away or bevel the inside edges of all the scrolls, a 1/8-in. bevel being about right.

Materials for the Case

No.	T	W	L	Parts
				For Case
1	1/4	6	11	Veneered mahogany for sides
1	3/4	6 1/4	15 1/2	Pine for top
1	3/4	4	15 1/2	Pine for base
1	3/4	3 1/4	30	Mahogany for molded base molding
1	3/4	11 1/2	15	Pine for backboard
2	3/4	1 1/2	11	Pine for back strips
1	1	1	1 1/2	Pine for corner blocks
1	1	1	3	Pine for center block
3	1/4	1 1/2	4 1/2	Mahogany veneer for scrolls
1	3/4	1 1/2	11	Mahogany for pilasters
2	1/4	1 1/2	7	Mahogany veneer for molding for top and base
2	1/4	1	11	Mahogany veneer for front corner blocks
1	1/4	2 1/2	17	Mahogany veneer for base molding
1	1/4	2 1/2	4 1/2	Mahogany veneer for base corner blocks
1				Brass ornaments
				For Clock Door
2	1/4	1	1	Mahogany veneer for sides
2	1/4	1	4 1/2	Mahogany veneer for ends
1	1/4	3/4	12	Mahogany veneer for molding
				Brass hinges and catch

Note: Make door cross-grained as shown in drawing

The pilasters are plain except for the cuts at the top and bottom. Each one is set in place near the front edge of the case.

The door is made of 1/4-in. stock with mitered corner joints. Note the direction of the grain of the face veneer. The door hinges are unique—merely two small pieces of brass made as shown and fastened to the door as at *A* in the drawing. A small round-head brass machine screw is used as a pivot.

The three ornaments should be of brass and similar to the design shown. Copies are available but some readers may prefer to form a pattern and have castings made. Fairly good-looking ornaments can be turned on the lathe out of the wood, gilded or simulate brass.

At the back edge of the case beyond the pilasters are two thin strips of wood 1/2 by 1 in. and 41 in. In the original clock some thin strips of wood are fastened inside to support the clock works and dial.

In finishing or staining the case, do not use a red mahogany stain. A brown shade is far better and more like the original case. The front surface of the three blocks at the top is almost black in color, offering a pleasing contrast with the wood material. Terry also made these clocks with the posts veneered with satinwood or maple.

One coat of brown mahogany oil stain and varnish stain followed by a wash coat of thin shellac and two coats of varnish, will prepare the clock for use.

Mr. Bryant has prepared a list of dealers in clock movements, brasses, veneer panels, and other supplies. This will be sent to any reader upon receipt of a stamped and self-addressed envelope.

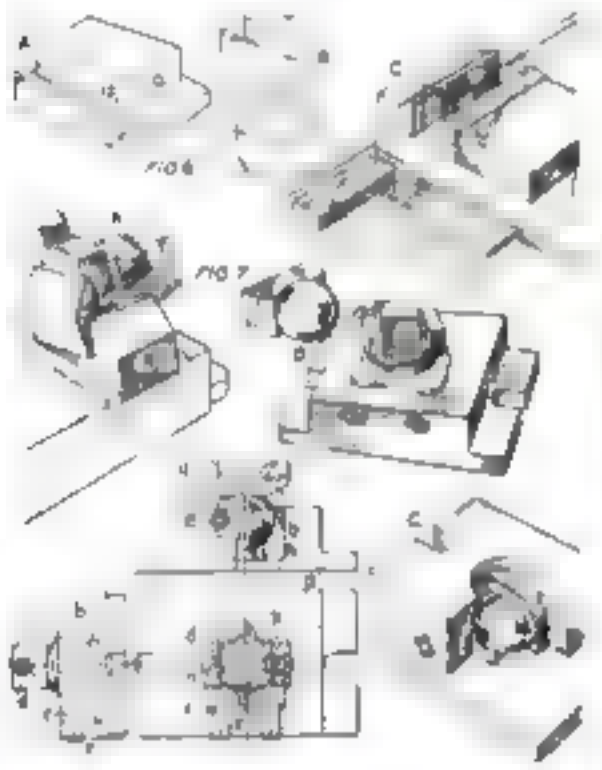
Simple Angular Set-Ups

(Continued from page 96)

are shown in Fig. 4. These permit the angle to be varied from zero to several degrees and set to very fine limits by means of a micrometer. The contact edge should be very slightly and evenly broken, and it is best to make the fixed distance L equal to some whole number, say 1 in. 2 in. 6 in.

The views show the approximate formula for figuring the height H stamped right on one side of the block with the value of L inserted. Where the block is habitually used for several different angles, it pays to stamp these angles and the corresponding heights H into the face of the block, as shown at C. All that you do then is to set the screw by the micrometer to have the angle without figuring.

Such sine parallels are fine for many jobs, but there are cases where the cut is so heavy that something solid is absolutely required, or where for some other reason it is desirable to set the whole vise at an angle. This can be done by the use of fixed angular blocks underneath the vise, as shown in Fig. 5. Cast-iron or steel blocks, with single and compound angles, are seen at A and B. At C a large one



Why correct alignment is essential setting compound angles and a small universal vise

is being poured from babbitt. Such a block will give good service unless it is necessary to remove and replace it very many times. A flat steel plate a, used as a mold for the bottom, is held at the desired angle by four pins b registering against the vise surface. The ends are sealed by strips of babbitting compound while the opening in the bottom of the vise is closed by a sheet metal strip c held in place by nuts of the compound. It is important to provide at least two locating lesses by drilling and reaming shallow holes d in the vise bottom to provide against displacement.

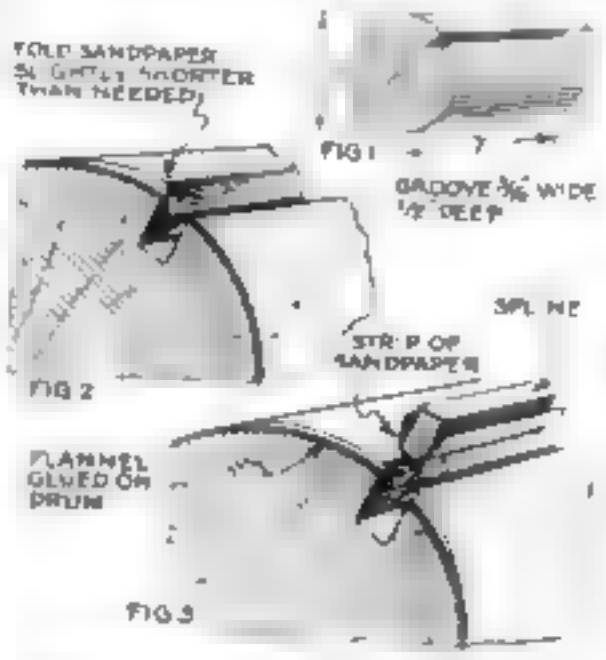
All the way through in angular holding it is important to bear in mind that any shift of the work out of alignment will result in a new angle, for some reason, this fact is frequently overlooked. The slight disalignment of the block representing the work in Fig. 6 at I with reference to the angular base is bound both to decrease the intended angle a, and to throw the edges out of parallel. The exaggeration in the diagram at H plainly shows the how and why. Therefore it is essential to line up the work carefully in the proper position. This is being done on the magnetic chuck at C by means of a square, although for very particular work a more positive way is that of indicating the vise jaw or the work itself.

Though compound

continued on page 126

How to Prepare a Lathe Sanding Drum

SANDPAPERING the edges of boards, especially the irregular edges of scroll saw work and concave curves of various kinds can be done easily if a wood-turning lathe is available. Simply turn a perfectly true mandrel of wood of any convenient size, say 3 in. in diameter and 7 in. long, and before removing it note the position of the spur center so that



After the drum is made the paper is held in place with a sandpaper covered wooden spline

the drum may be replaced the same way and remain properly centered.

Cut a groove as shown in Fig. 1 and glue a piece of old blanket or flannel around the drum. Cloth that is too thin makes a hard drum and thick, soft padding causes the paper to creep. Cut the sandpaper as wide as the drum is long and have it long enough to fold down into the slot, but not so long that the ends will reach the bottom of the slot. Make two folds with a straightedge in such a way that when one fold is in the center of the slot as in Fig. 2 the other fold will just go in.

After preparing a spline to fit the slot, coat a strip of sandpaper about ¾ in. wide, wrap it over the spline with the sanded surface out and drive the spline in place as shown in Fig. 3. — GRAHAM STOKES

Simple Angular Set-Ups

(Continued from page 125)

angles are very common as anyone who has guessed a few of them is frequently experienced in preparing them when they are wanted. A simple expedient for small work of ordinary accuracy is the combination of two squares used with a machine-table vise as at B in Fig. 7. In many instances one of the vises may be dispensed with by placing the work itself at an angle although for duplicate jobs the combination of three vises will often be found better.

A homemade universal toolmaker's vise for small and quite light work is shown at B. It consists of a cast iron base a with a split socket b, in which the ball c of the holder d is clamped by the action of two large set screws e through a pressure plate f. The socket is produced by casting hard babbitt around the ball and I use it in the manner shown at f. After the babbitt has been poured, the form is knocked out, sawed on two at g and the lower b thinned down a few thousandths. The ball is ground down flat to about one fifth of its diameter and the holder or vise carefully sweated on to it. With this little auxiliary many difficult and delicate parts can be easily handled on the grinder, miller or lathe. As steel balls are cheap and the socket is easily removed or replaced, a number of holders may be used with the same base.

A Lockheed Model

(Continued from page 46)

desired thickness. Make the plug for the rear end with a bamboo pin to fit the notch in the body shell. Cut the windows with a very sharp knife or broken razor blade. Draw the door outline with pencil.

The bare shell without fittings should weigh less than 1 oz., but if you have made an exceptionally light body it may be advisable to cement balsa formers at intervals on the inside. These formers should have a hole at least 1 by 1½ in. to allow the rubber motor to pass. Cement the two halves of the body together.

Make the elevator rubber, and tin units, and cover the surfaces with goldbeater's skin. After the skin has been cemented and trimmed, moisten it with water, but brace the elevator surfaces up on several books so that they will be held flat while the skin shrinks.

Make the dummy Wasp engine and paint it black. Attach the tail skid. Cut off the top of the body parallel to the center line as shown to make a flat place 6½ in. long for mounting the wing. This flat part, which begins exactly 9 in. from the front end of the body, must be very accurately located. Cut slots in the center of the top in front of where the wing is to be mounted ready for the installation of the uprights or cockpit enclosure. Install temporary braces across the opening in the top of the body until the wing is ready. Apply cement to the nose of the fuselage to stiffen it.

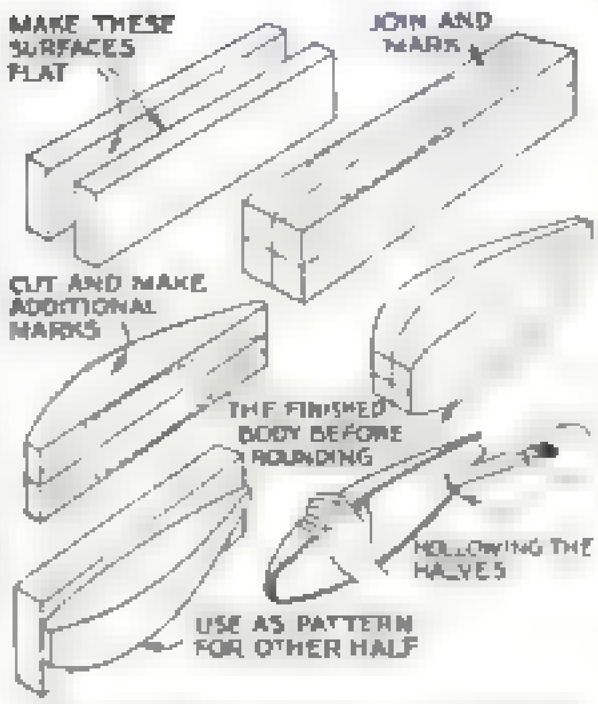
A standard type bearing is mounted on a motor stick ½ in. square and only 6 in. long. The sticks fit (Continued on page 146)

List of Materials

4 pcs. 1/16 by 4 by 10 in. balsa wood for the body
1 pc. 1 by 1½ by 11½ in. for rear fuselage plug
1 pc. bamboo
1 pc. No. 18 music wire 14 in. long. No. 14 can be used satisfactorily on a very light model
3 pcs. wire, German steel, ⅛ in. in diameter and 12 in. long for fin and elevator edgings
3 pcs. ⅛ by ⅛ by 20 in. balsa for spars and ribs of elevator and rudder
2 pcs. ⅛ by 2¼ in. square balsa from which to turn the wheels, or two very light weight 2-in. celluloid or aluminum wheels
2 washers or cyclets for wheel bearings
2 heavy bank pins or two heavy piano-hinged pins for axles
1 pc. ¼ by ¼ by 20 in. and one piece ¼ by ½ by 20 in. balsa for landing gear struts
1 pc. 6 in. square of thinnest celluloid obtainable, for windows; transparent colorless cellophane candy wrapping may be used
Nine 1- or ½-oz. bottle corks for dummy cylinders
Eighteen common pins for dummy push-rod housings
One length of small radio spaghetti tubing for manifold pipes
1 pc. 3/16 by 1⅝ by 8½ in. balsa for propeller
Three small washers for propeller shaft
One ½-oz. can of airplane or celluloid type cement
One 1-oz. bottle paper cement
One sheet goldbeater's skin for covering control surfaces. Japanese tissue may be used instead.
One propeller bearing.
1 pc. 3/16 by ⅜ by 3½ in. balsa for tail skid
1 pc. ½ in. square balsa 10 in. long for motor stick and crosspieces

A Lockheed Model

(Continued from page [illegible])



Steps in shaping the body. Fasten the blocks temporarily with staples or balsa plugs.

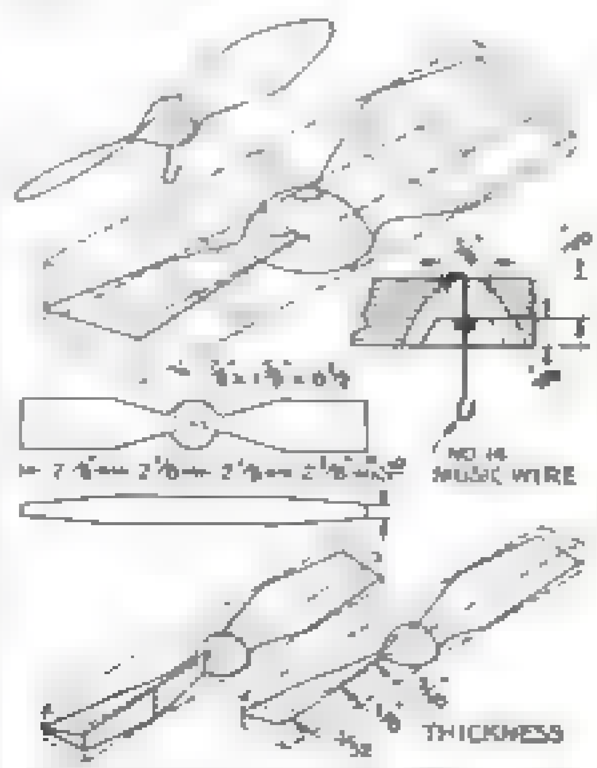
snugly into two wire cups cemented to and supported by two 1/8 in. square balsa pieces extending crosswise of the fuselage where indicated by dotted lines in the side elevation. This stub motor stick should fit snugly enough in the cups so that it will not rotate, yet loosely enough to be withdrawn when necessary.

Landing Gear. Prepare the struts and cement them in place. If you prefer, you can substitute 1/32 in. reed for balsa in making the landing gear. Cement the axles at the outer ends of the strut junctions.

Propeller. Lay out and carve the propeller as shown below. The dummy spinner is carved right on the propeller itself. It is hollowed as shown. Insert and cement the shaft and give the propeller three coats of paper cement with a light sandpapering between coats. Balance the propeller very accurately and install three washers on the shaft.

How to build the wing, assemble the model and fly it will be told in the October issue.

To aid those who have had little experience in building model airplanes, Mr. Johnstone has prepared some additional notes and suggestions. These will be furnished free to anyone who sends a self-addressed and stamped envelope and asks for Home Workshop Bulletin No. 1.



How to lay out and carve the true pitch propeller made in one piece with dummy spinner.

How to Build Our Screen Grid Distance Getter

(Continued from page 71)

the center, between shields Nos. 2 and 3.

The next job is to make the subpanel on which the screen grid tube sockets are mounted. This can be thin wood, plywood, or, if you prefer, bakelite. The exact dimensions are unimportant so long as it occupies about the space shown in Figure 1. This subpanel should be mounted on the end of long No. 6-32 machine screws passed through the bottom of the base, with nuts on the screws to hold the panel in place. The top of the subpanel should be covered with thin sheet aluminum or thin sheet brass, or even thin sheet iron if no other material is available. In fact, iron is just as good at this point in the circuit as any other material. Four Y-type sockets should be mounted in the position shown on the subpanel, with the P terminals pointed diagonally toward the adjacent shield. Connections are made to all of the socket terminals except the P terminal through holes drilled in the subpanel. Use large holes (¼-inch is satisfactory), and be sure that the hole through the aluminum is slightly larger than the hole through the wood or bakelite, so that there will be no chance of a short circuit. Mount condensers *C9* and *C10*, as indicated, on top of the subpanel, using one of the holding down screws for these condensers to mount one end of resistance *R1* and resistance *R2*. These resistances are clamped underneath the subpanel. By this arrangement one end of each of these resistances is connected to the aluminum shield by way of the holding down screw. The other end of each one of these resistances should be connected respectively to the K terminal of the first socket and the K terminal of the second socket, reading from the left in Figures 1 and 2. Resistance *R3* should be mounted by means of a 6-32 bolt in approximately the same manner between the second and third sockets so that its free end is close to the K terminal of the third socket.

RESISTANCES *R4*, *R5*, and *R6* are fastened to the baseboard underneath the subpanel and ends of each of these resistances are connected together and to the center terminal of potentiometer *R7*.

Remove the subpanel, complete the filament wiring, and solder leads to the other socket terminals so that you can connect in place after the subpanel has been bolted down. Now mount the remaining by-pass condensers on the sub-base and also the radio-frequency choke coil *D4*. The tube shields, if they are of the commercial variety, are tubular, with a cap for the hole on the small end; the large end is open. Be sure that you select sockets small enough so that the tube shields can be slipped completely over the sockets to make contact with the sheet aluminum. A slot must be cut in the bottom edge of each tube shield to allow the plate leads to be brought out in the coil spring shield. If you cannot obtain the necessary brass coil springs for shielding, use ordinary copper tubing. Bend to shape. You will note in the shield grid tube assembly that each screen grid tube is shielded by the cylindrical shield, and it is even shielded underneath by the aluminum sheet on the sub-base, with both the control grid connection at the top and the plate lead from the bottom of the tube shield also shielded by the brass spring or copper tubing. There is, therefore, no possible chance for capacity coupling between the plate and control grid leads of any of the tubes.

Wiring the Receiver

THE first job is to connect the tuning coils with the tuning condensers, that is, complete the connection to coils *A1*, *B1*, variable condenser *C1*, and (Continued on page 130)

How to Build Our Screen Grid Distance Getter

(Continued from page 129)

coils *A2*, *B2*, and variable condenser *C2*, together with the connections to the radio-frequency choke coils *D1*, *D2*, and the by-pass condensers *C3*, *C11* and *C4*. Refer to the picture diagram of Fig. 2.

When you have completed these connections take the back side of the shield which houses coils *A1*, *B1* and drill a hole for the control grid lead to the first tube. This should take the form of a slot near the top edge, as clearly shown in the illustrations in Figures 1 and 3. Also drill a hole for the antenna lead wire. Now take the side of the shield that houses coils *A2*, *B2*, that is adjacent to radio-frequency choke coil *D1* and drill a hole for the lead to the terminal of *D1*. Then take the back of the same shield and cut a slot in the top edge for the control grid lead and a hole near the bottom for the plate lead. The latter hole will have to be quite large to allow the shielding arrangement. Do the same for the third shield and for the fourth shield. In the shield holding coil *A4*, *B4* there is one hole for the wire leading to choke *D3* and in the back of the shield a hole for the plate lead to the screen grid tube, a hole for the twisted pair leading to the heater terminals of the 227 tube socket, a hole leading to one terminal of choke *D4*, and a hole for a wire to the K terminal of the 227 socket.

AFTER you have made these connections complete the wiring under the sub-base. Clamp it in place. Make connections from the flexible leads attached to the socket terminals and to the fixed condensers, and complete the wiring according to the picture wiring diagram of Figure 2.

Connecting to Amplifier

FIGURE 7 shows a conventional two-stage audio amplifier which can be built as a separate unit to be used with this receiver. The only additional apparatus you will need will be a transformer to heat the filaments of the 224 and 227 tubes and also the 171A tube, a good B-eliminator, home built or factory built, and a loudspeaker. In this circuit minus-B is grounded and is also connected to the aluminum sheet on the sub-base and to all the shields that house the tuning units. A strip of thin sheet metal can be placed under the four shields so that when they are clamped down they all will be connected. An extra strip can be brought out and connected to the sheet of aluminum or other metal on the sub-base. Then the minus-B connection can be made to any of the bolts that hold the sub-base in place. The wire leading from *D4* should be connected to the P terminal of the first audio transformer, or if you use only one audio stage to the P terminal of the single audio transformer. Note that the voltage applied to the detector circuit is given at two values, either 90 or 180. If you use a two-stage audio amplifier use 90 volts and use a C-battery of 9 volts. If you use only the last or power amplifier stage, use 180 volts on the detector circuit and a corresponding C-voltage of 18.

While it is possible to obtain the necessary C-voltage to operate the power detector from the B-eliminator, it is simpler and more satisfactory to use a separate dry cell C-battery. The positive terminal of this C-battery should be connected to the lead that is brought out from the cathode terminal of the 227 socket, and the negative terminal of this C-battery should be connected to the minus-B wire at any point. No binding posts are used on this receiver—the lead wires are brought out to be connected to the proper terminals of the B-eliminator circuit. (Continued on page 181)

How to Build Our Screen Grid Distance Getter

(Continued from page 130)

After you have the B connections properly made and the connection made to the amplifier circuit with, of course, the loudspeaker connected, turn on the alternating current supply to the filament heating transformer and to the B-eliminator. Then you will have to wait for a short period until the tubes warm up to operating condition. Tuning, of course, is accomplished by using the four dials. You will find that the two center dials tune practically alike, whereas the end dials vary somewhat. Volume is controlled by turning the knob on *R7*. If you turn this knob too far with some tubes the receiver will break into oscillation and start to squeal. The most sensitive point for reception, of course, is just below where the receiver starts to squeal.

The Right Antenna

THE proper antenna to use with this set depends on your location. If you are hundreds of miles away from the nearest broadcasting station it is desirable to use an outdoor antenna, usually not over fifty or seventy-five feet long. Use also the tap on the antenna coil which puts the most number of turns into action. In any ordinary location, however, you will find that a short indoor antenna is all you need. In fact, even in unfavorable localities it is possible to bring in distant stations on an indoor antenna not over eight or ten feet long. Consequently, we suggest that you try the receiver first with a ten-foot wire as an antenna, simply strung across the room. If this is not sufficient because of excessively poor conditions, try using a longer antenna until you strike the right length. If you encounter any difficulties in construction or you desire any special advice or information with regard to adapting the receiver to your own particular conditions address your letter Technical Editor, POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York City.

Telephone Talk Is Tested by Queer Sentences

IF YOU should happen to visit the Bell Telephone Laboratories in New York City, and there overhear an engineer telephoning, "Joe took father's shoe bench out," or "She was waiting at my lawn," over and over again, he is not merely repeating meaningless phrases. He is testing the audibility of transmission lines and instruments with sentences carefully constructed for the purpose.

The two phrases contain the five vowels and the two diphthongs y and ou, as well as the ten consonants r, l, m, n, ng, j, g, sh, ch, and s, the reproduction of which is essential to clear understanding of everyday English over the telephone. Moreover, the two phrases represent the two types of sentences most frequently used. The one beginning with "Joe" is a choppy, staccato line, while the other is smooth and flowing.

Phone from Ships at Sea

OCEAN travelers soon may talk in mid-ocean to their families and business associates ashore. Radio telephone equipment was installed recently aboard the steamship *Leviathan* of the United States Lines and successful ship-to-shore experiments were conducted. A regular marine telephone service is promised by officials of the American Telephone and Telegraph Company.

The new type of communication will be accomplished by a combination of radio and telephone. A radio transmitter aboard ship will send the mid-ocean message to a shore station, whence it will be relayed over telephone wires.

A definite program for getting ahead financially will be found on page four of this issue.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Scorching in My Horseless Carriage

(Continued from page 11)

up you could count on having every other automobilist stop to ask if he could help, and to be quite willing to. There were not many cars, the whole thing was so new that owning one made you a brother-in-arms to every other owner, and the courtesies of the road that developed were very pleasant. One place where it showed was in dealing with horses. Automobiles were unpopular among horse owners, to put it mildly, and for the general promotion of friendship you were careful not to make things any worse. When you saw a horse coming you pulled over to the side of the road and stopped; if he was skittish you would even stop the engine and get out to lead him past, with the driver telling you just what he thought of you and your vile machine.

At first sight, the 1904 Studebaker looked a good deal like the Cadillac, but was larger and more powerful. Its wheelbase was eighty inches, and with a two-cylinder fifteen horsepower engine its makers claimed that it could go thirty-five miles an hour over suitable roads. With a detachable rear-entrance tonneau it cost only $1,075, and while that did not include a top it gave side and tail lamps—oil—and a bulb horn. With a permanent tonneau it cost $100 more. A comparison of that car with the 1929 Studebaker that can be bought for the same money is something to think about.

THE Buick is another example of what has happened in twenty-five years. Today $1,300 or so will buy a car that is and has almost everything that could be wanted. The 1904 Buick was a five-passenger touring car of eighty-five-inch wheelbase with a two-cylinder twenty-two-horsepower engine, and it cost $1,400 without any accessories, just the bare car. It was fast, too; the makers proudly advertised a record of 108 miles in three hours and thirty-seven minutes.

It was a great day for the automobile when the engine came out from under the body and stood itself up in the open. One of the first one-cylinder cars to be built that way was the Overland, which had a five-horsepower engine in front and drove through a chain to the transmission and another to the rear axle. Another was the Pierce-Arrow Stanhope, but that had its eight-horsepower engine on the rear axle and drove through spur gears. Without a top it cost $1,200.

THE final drive of most of the cars of that day was by chain. Some had a single chain to the differential of the rear axle and some a chain from the ends of a differential shaft to each rear wheel. The chains were out in the open with nothing to protect them from dust and grit, and no matter how often they were cleaned and oiled they were forever stretching and breaking. A chain repair kit was as necessary as gasoline and a repair job always meant crawling under.

The spur gear drive of the Pierce Stanhope was one of the attempts to get something better. Pierce was trying out a shaft drive on his four-cylinder car, and so were some of the others, with everybody else saying that it wouldn't work because the teeth of the bevel gears couldn't stand the strain. Nor would they, for that was only one of the parts of a car that showed the need for improvements in metals. Steel that stood up in locomotives and machinery in general would go to pieces in an automobile. Today we have the finest steels the world has ever seen, and it is the automobile that can be thanked for it.

The four-cylinder Pierce-Arrow was a top-notcher. The engine was in front and rated at twenty-eight horsepower. The frame was steel and the body cast aluminum. It had a three-speed sliding gear. (Continued on page 137)

Scorching in My Horseless Carriage

(Continued from page 132)

transmission, and when it was right could do thirty miles an hour. The wheelbase was 100 inches, and with a top, side lamps, and acetylene headlights could be bought for $5,700. In 1929, by way of comparison, $2,775 will buy a Pierce-Arrow of 133-inch wheelbase with a 125-horsepower straight-eight engine that will hold eighty-five miles an hour, and that is the last word in body design and in equipment.

The Packard of 1904 had just as much class and was about the same in size and price; 106-inch wheelbase, four-cylinder twenty-eight-horsepower engine in front, sliding gear transmission, shaft drive, pressed steel frame. Without top or headlights the price was $5,500. Peerless ran them both close in design and style, but was a little smaller and cheaper; 102-inch wheelbase, twenty-two-horsepower engine in front, and priced $5,000 without top. All three were considered very modern, especially for their side-entrance tonneaus. This was a new idea, and many of the makers were still shy of it because they thought it weakened the body. Doors in front were still years away

THAT was a time when all sorts of new things were being proposed, and one that was tried by many makers was air cooling. Corbin, Aerocar, Waltham, Crestmobile, Knox, even the early Marmon, were air coolers, but Franklin was the only one that lasted. The most popular 1904 Franklin was a four-cylinder twelve-horsepower runabout with the engine set crossways in front for equal cooling. With a wheelbase of eighty-two inches this car weighed 1,175 pounds, and without a top it cost a modest $1,500. The Marmon four-cylinder air-cooled V engine was replaced by a water-cooled four-cylinder vertical.

Steam had been tried, and by 1904 was going out. Locomobile was originally a steamer, as were Toledo and Stearns, but by that year all three of them had changed to gas. The Stanley steamer was still popular, while the White was in a class by itself. There has never been a smoother driving car than a steamer or one that gave a greater sense of power, but with the pressures that were carried—up to 800 pounds in the White—there was continual trouble with leakage. It used to be said that white trouble with a steamer could be located in a minute, fixing it took an hour, and with a gas car it was the other way around, an hour to locate and a minute to fix

ANOTHER objection to a steam car was slow starting, for heating the burner and getting up steam might take up to half an hour. Here was a great advantage of the gas car, for if all was well, it would start with a few swings of the crank. This, however, was none too easy. Self-starters were still a beautiful dream in 1904, and a session with the crank was a preliminary to every trip. What with carburetors that wouldn't "carb" and ignition systems that wouldn't "ig," you cranked; take it from one who knows—you *cranked*. Cranking was an art, and you learned to do it with your left hand, so that a kickback would not be so likely to break your wrist. It was not so bad with small cars; but anyone who has tried it knows that pulling a five by five four-cylinder over compression is a real job, and that keeping it up when the engine is cold and balky takes all of the endurance that there is. More than any other one thing—more, almost, than everything else put together—it is the self-starter that changed the automobile from a sporting vehicle of uncertain temperament to one of universal usefulness.

Improvements in tires have had something to do with that, too. I heard a friend complaining the other day that a tire had blown out after "only 12,000 miles." In 1904 he would have been lucky (Continued on page 134)

Scorching in My Horseless Carriage

(Continued from page 133)

to get 3,000, and if a tire of his had run 1,000 miles without trouble everybody would have heard of it. There were no demountable rims; the rim was part of the wheel and the castings were bolted on with lugs through the felloe. When you had a puncture you packed up, unscrewed the lugs, pried off the casing, put in a new tube, pried the casing back, screwed up the lugs, and pumped, and pumped, and pumped. If the new tube was pinched in the process, you repeated. Anyone who could make a tire change within an hour and without losing more than five pounds was distinctly good.

The only nonskids had metal knobs molded in the tread. They were imported and therefore expensive, so most of the cars had smooth treads, and how they skidded! Skidding was so usual that no one even mentioned it unless the car made at least one complete turn, and even that was hardly worth talking about.

Yes, automobiles have changed in these twenty-five years. And reckoned in any way that you please—by horsepower size, weight, speed, comfort and convenience, length of life or any other standard—the increase in purchasing power of the automobile dollar is one of the most amazing developments of the most amazing era the world has ever seen.

Beating the Evolution Laws

(Continued from page 12)

changed his text to conform with the act.

In the new book, the chapter "The Human Organism: Keeping It Fit" contains most of the indirect evolution teaching. There are numerous diagrams showing comparative anatomy. At the top of page 274 are shown "Anterior limbs of vertebrates"—of the frog, partridge, man, dolphin, and blackfish, with this caption: "The limbs of the different classes of back-boned animals are so distinct that most people never discover that they are all different forms of the same organ."

But in the old version, there appeared an illustration showing the hind and fore limbs—legs and arms—of man, gorilla and lemur, with the caption, "Limbs of Primates—the highest order of mammals." On the opposite page was a picture of the skeleton of man compared with that of the lemur and the gorilla. In the new edition, this picture has disappeared and an illustration of the skeleton of man only has been substituted.

JUST how difficult it is to "get by" the law is shown by a compilation of scientific books in use in Arkansas normal schools by Professor I. P. Daniel, teacher of biology in the State Normal School at Conway, Ark. He found that of approximately seventy books on botany, biology, zoology, and closely related subjects in use at his school as texts or reference works, about fifty taught evolution of man as a fact. Of the remainder, half taught evolution as a fact and implied that the theory included man, and the other half specified that evolution is a theory with varying degrees of emphasis as to its probability.

Tennessee's antievolution law makes the teaching of the theory illegal, but does not concern itself with either text or reference books. However what exactly is "teaching"? A number of instructors in the state have adopted the plan of reading to the students any matter they consider objectionable under the law, directly from the text, without making any comment on what they read. Thus they evade the law by not *teaching* evolution.

"I am quite sure they are within their legal rights when they follow this plan," Henry Fulton, a Nashville, (Continued on page 145)

Beating the Evolution Laws

(Continued from page 134)

Tenn., attorney, told me. Mr. Colton was the chief counsel for Scopes when the famous case was carried to the Tennessee Supreme Court. "They cannot be teaching in the legal sense," he added, "unless they are commenting and explaining."

THIS particular method of evasion is, of course, out of the question in the state of Arkansas, where the "use" of textbooks containing the prohibited material on evolution is unlawful. It certainly would not take even a mediocre district attorney long to convince a jury that reading from a textbook was a form of using it.

Another ticklish problem is presented by laboratory and museum exhibits in higher institutions of learning. For example, in the biology department of the University of Arkansas, at Fayetteville, in a laboratory devoted to exhibits for study in zoology and anthropology, there is a row of skeletons of the primates. This particular exhibit is the pride of the anthropological collection, which is one of the best of the universities of the South. An erect skeleton of a man stands proudly at the head of the group. Next to him, bent forward somewhat, is the bony framework of what once was a huge gorilla. Third in line is the skeleton of a chimpanzee, then of an orang-outang, of a baboon, and so on down the scale of smaller monkeys. Another interesting and unique collection in this university museum is a group of skulls, showing the development of man's cranial capacity and structure from dim antiquity to the present.

"Now, what are we to do with all this?" asked one of the University's instructors in science as we stood looking at the exhibits. "Do the people of Arkansas want us to throw these almost priceless collections away? We want to use them in our teaching, but we do not want to be arrested for it.

"I'll tell you how they can get by," an obliging student of zoology who had overheard this conversation, remarked to me later. "They can point out facts of life and life history to us in an unrelated way without saying anything about evolution. That will get them by the law. Then let us use our own intelligence!

Naturally, the law, both in Arkansas and Tennessee, has only the power to forbid the teaching of evolution in state-supported institutions. On the campus at Vanderbilt University, a private institution at Nashville, Tenn., stands a new and splendidly equipped science building, named Buttrick Hall, in honor of William Buttrick, long a trustee of the university. The building was erected under the direction of Dr. E. E. Reinke, head of the department of biology in Vanderbilt, whose name figured prominently in the defense briefs of the Scopes case. It was Dr. Reinke who declared during the trial:

"THE theory of evolution is altogether essential to the teaching of biology and its kindred sciences. To deny the teacher of biology the use of this most fundamental generalization of his science would make his teaching as chaotic as an attempt to teach astronomy without the law of gravitation. The theory of evolution can in no wise deny the existence of a Creator; it is merely an attempt to give an accurate explanation or interpretation of His procedure.

"This building," Dr. Reinke told me, "is our answer to the antievolution law. Our institution is not under state control. We openly feature evolution in our science work, so that it can be known that scientific investigation has an unfettered haven here in a state where so many science teachers are having to evade the law and teach their subjects under severe handicaps.

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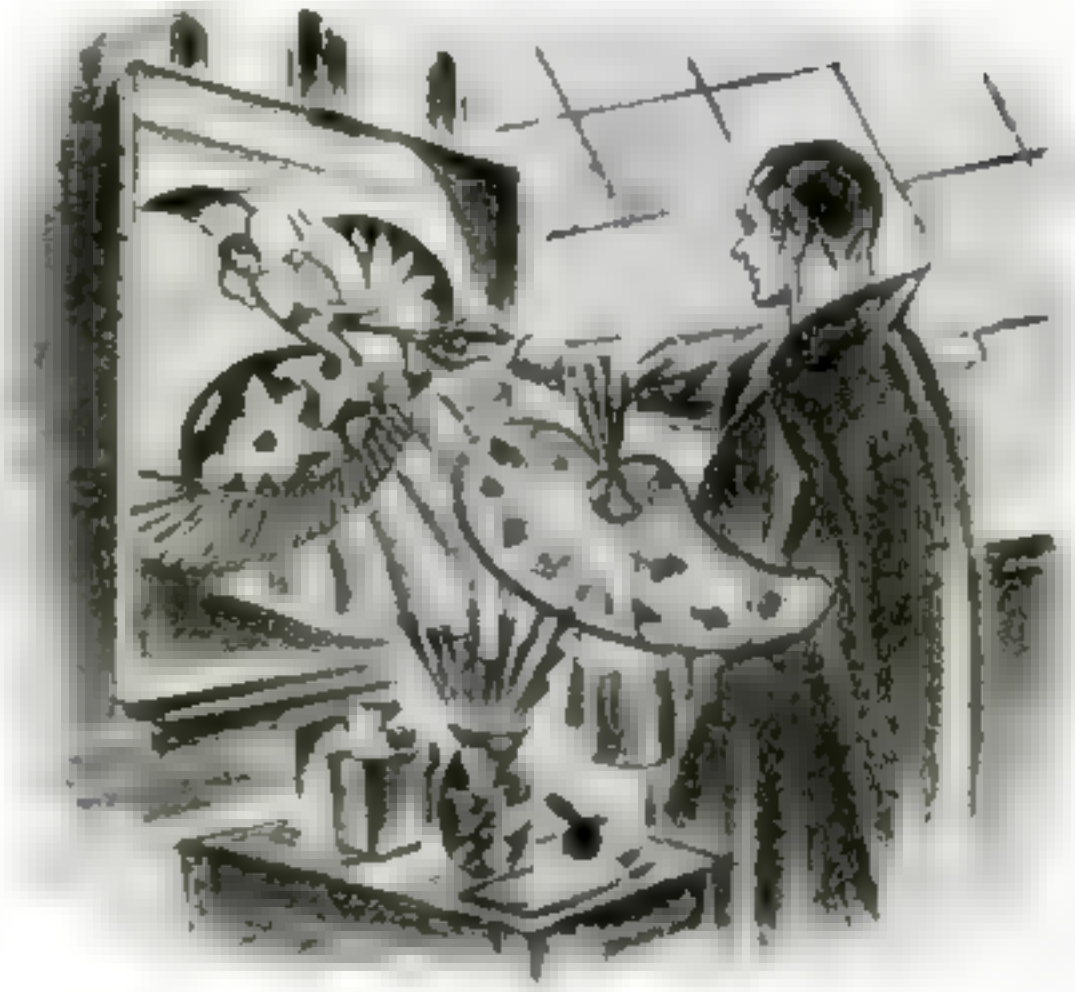

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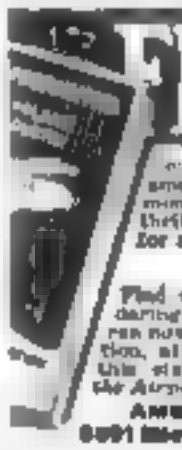

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Men in the Public Eye

(Continued from page 51)

He soon found that other astronomers had worked out the same theory. But then an entirely original idea came to him—that the movements of comets were governed by the same principle as that of the moon. The heaviest part of the comet must stay nearest the sun as it goes around it. And, since the head is much heavier than the tail, the center of gravity must naturally lie in the head.

Some weeks later, while in Paris, a friend of Powell's took him to see Flammarion. The conversation again drifted to comets and the veteran scientist, unaware that his guest knew anything of astronomy, explained their peculiar motions in simple terms.

"What is your theory of the action of the comets' tails?" asked Powell.

Flammarion gave the familiar explanation. Then Powell offered his new theory. The old astronomer was amazed and delighted.

"You are right!" he exclaimed. "Will you write down what you have just said to me? I shall present it to the Société Astronomique de France. It is one of the most startling discoveries of the day!"

AND that is how an American musician came to be elected a member of a famous French organization of scientists.

Powell, who was born in Richmond, Va., in 1886, was graduated from the University of Virginia. He studied music first with his sister and later with Leschetizky, the great Austrian pianist, and with Nawratil, the Viennese composer. He has played in concert with considerable success in the United States and in the principal music centers of Europe.

Little Giant of Aviation

INCREDIBLE though it may seem, psychoanalysis was responsible for the fact that Giuseppe Mario Bellanca, the distinguished designer of airplanes, embraced aviation as a career.

About twenty years ago, when Bellanca was graduated with honors from the Royal Institute at Milan, there probably wasn't a more melancholy youth in all Italy. He was sick at heart and in body. Much reading of the works of pessimistic philosophers had soured his outlook on life. Besides, he was suffering from a strange temporary twist of his mentality. He could, at will, produce excruciating pains in any part of his anatomy, and because of the depression of his spirit, he was constantly tempted to indulge in this curious form of self-torture.

AFTER consulting specialists who failed to give him relief, Bellanca visited one of the early followers of the Viennese school of psychologists who endeavor to cure various ills by probing into the patient's subconscious mind and there exposing the inhibitions and repressions that may cause psychic or physical disorders. The psychoanalyst, in a searching examination, learned that Bellanca, when a small boy in the town of Sciacca, Sicily, where he was born in 1886, had been passionately fond of flying kites and of sailing flat fragments of stone against and with the winds. He found that the news of the Wright brothers' flight in the first airplane in 1903 and of Léon Delagrange's recent breaking flight in France a few years later had made indelible impressions on the lad's mind. Finally he discovered that Bellanca, before going to Milan, had actually built an airplane of his own design, but had crashed and wrecked the machine in his initial attempt to take it off the ground.

"I see," said the specialist after listening to the story. "And what do you mean to do now?"

"Well, I studied efficiency engineering at the Royal Institute," replied Bellanca, "and it was my plan to follow that profession."

The doctor advised him to do nothing of the kind. He diagnosed his ailment as the result of a repressed desire to fly. And as the only effective remedy he prescribed—flying. Bellanca promised to heed his counsel.

The young Sicilian, with his family, came to this country in 1911. They settled in Brooklyn, N. Y., and Guiseppe, remembering the doctor's advice, spent most of his waking hours at the flying fields on Long Island. Meanwhile, he built a plane in the cellar at home with the aid of his father, who did much of the woodwork, and of his mother, who sewed the wing fabric. The model was a parasol monoplane, built along new lines designed to eliminate as much structural resistance as possible, and equipped with an air-cooled motor.

DERISIVE laughter and gloomy predictions greeted the little Italian (he is only five feet three inches tall) when he wheeled his creation onto the field. He heeded neither and taught himself to fly in it. From that day on, he has been a well and happy man.

Bellanca ran a flying school from 1916 to 1917, was consulting engineer with the Wright Aeronautical Corporation, and finally began designing and making airplanes in an old shipyard on Staten Island, N. Y., which he had converted into a factory. But recognition did not come to him until almost ten years later, when he originated the streamline cabin. This idea, too, was ridiculed at first, but it was not long before cabin monoplanes far outnumbered every other type of aircraft. Soon orders began to pour into the shop. Meanwhile, Bellanca won every efficiency contest he entered at the National Air Races. Last year at Los Angeles his entries captured both efficiency trophies. In 1926, at the Sesquicentennial meet in Philadelphia, he won with a total of points exceeding by fifty percent that of his closest rival.

The chief distinguishing feature of a Bellanca plane is that a lengthwise cross section of its body, convex on top and flat at the bottom, resembles that of a wing. This tends to increase the lifting surface of the plane in flight without adding to its weight.

BELLANCA is a man of such retiring nature that the public was scarcely aware of his existence until June, 1927, when Clarence D. Chamberlin, with Charles A. Levine as passenger, made his nonstop flight from Roosevelt Field, N. Y., to Eisleben, Germany, in the Bellanca monoplane *Columbia*, flying 3,911 miles in forty-two and a half hours and breaking Lindbergh's long-distance record.

The designer's overnight fame resulted in ample financial support for his enterprise from bankers and other business men. Today, Bellanca is the head of a great, up-to-date airplane manufacturing establishment at Newcastle, Del.

The man's innate modesty is best illustrated by his comment upon Chamberlin's epochal trans-Atlantic flight. Pressed for a statement, he offered this simple sentence:

"The flight has not added anything of moment to the science of aviation."

"Professor of Police"

TALL, spare, cultured, and bearing a striking resemblance to the late President Wilson, August Vollmer, chief of police of Berkeley, Calif., since 1905, who was recently appointed professor of police administration at the University of Chicago, presents the appearance of the typical educator rather than that of the traditional police chief. With the beginning of the fall semester, it will be his job to develop a great center for the scientific study of police.

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Men in the Public Eye

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methods, with the entire country as the field of investigation and research.

Although not college-trained, Chief Vollmer is a tireless student and an intensive reader and, according to his friends, requires little sleep. A. J. Dixon, noted English criminologist, has described him as "one American policeman and criminologist respected in Europe."

While an authority on methods of criminal detection, Vollmer has devoted most of his career to crime prevention work. An outstanding example is his recent coördination of the activities of the Berkeley schools, health and police departments, bureau of public welfare, and juvenile court for the study and prevention of juvenile delinquency. Conferences are held once a week in which individual cases are brought up for investigation and correction.

CHIEF VOLLMER was born in New Orleans in 1876, and attended the public schools and the New Orleans Academy in that city. In his early twenties he joined the United States Army as a private and served with distinction in the Spanish-American War and the Philippine insurrection. In addition to his work in Berkeley, he has been president of the International Association of Police Chiefs, and has made important contributions to the improvement of police administration as a consulting expert in San Diego, Los Angeles, Detroit, and Havana, Cuba.

Under the Vollmer administration the Berkeley police have been the first in the country to use cars equipped with radio for the reception of communications from headquarters, and they long ago employed experts on ballistics—the scientific study of firearms. The chief has made it an honor to belong to his force by establishing a high morale. He says men must measure up to high intelligence standards, with the result that many college graduates are serving as Berkeley policemen. The force has been the training school for chiefs of many American cities.

THE new University of Chicago professor is perhaps best known for his famous systolic blood pressure, or lie detecting machine, which has been used successfully in more than 10,000 cases. His own opinion of the device is that its evidence is mainly contributory. The machine records sudden changes in respiration, pulse, and blood pressure through which the suspect betrays guilty knowledge of the crime of which he stands accused.

One of Chief Vollmer's immediate objectives at Chicago will be to formulate standards of police practice which will be available to police forces everywhere.

Wins Degree at Seventeen

GRADUATION from college at the age of seventeen, after completing her entire education in less time than most children spend in grammar school, is the remarkable achievement of Miss Betty Ford, of San Francisco, who recently received a degree from Stanford University, California.

Only six years of her life have been spent in classroom, three at the University and three at a private high school. Her earlier training she received at home.

Betty has been called a genius by psychologists. She walked when she was seven months old, talked and knew the alphabet at nine months, read at three years, and at seven had a vocabulary of some 13,000 words. Now she is writing a novel.

Unlike most prodigies, she is an only child. Statistics show that a majority of unusually gifted persons have sprung from large families. Benjamin Franklin was a seventeenth child, Frederick the Great the third of fourteen, Napoleon the fourth of twelve.

A definite program for getting ahead financially will be found on page four of this issue

Here Are Correct Answers to Questions on Page 48

1. If the sink or some other drainpipe becomes clogged, first try a plumber's force pump. This consists of a large rubber cup on the end of a short handle. If this causes a small amount of water to flow through the drain, try one of the special drain-cleaning compounds. If this fails call in the plumber, who is equipped with a special flexible cleaning tool which can be forced through the pipe to remove the obstruction.

2. Water is virtually incompressible and when you shut the faucet suddenly, the moving column of water jars the pipe. Constantly closing the faucet in such a way that the hammer blow is produced is hard on the plumbing fixtures and piping. It can be eliminated by putting an air trap as close to the faucet as possible. The trapped air acts as a cushion and prevents the hammering.

3. Briefly, the advantage of hot water heating is the uniform home temperature that can be obtained with little attention to the furnace. It takes a long while to heat up a house with hot water but it also takes a correspondingly long time for it to cool off. Steam, on the other hand, has the advantage of quick heating, but requires more attention.

4. No useless kinks are placed in the drainpipe. The S-curved sections are traps and are placed there to prevent sewer gas from getting into the house.

5. It is quite practical to get a filter that will remove all of the solid matter in the water, but no filter attached to the faucet is capable of removing bacteria from the water. Filtering out germs and bacteria is possible only in specially designed installations which are carefully cared for by experts.

6. It is bad practice to drain the water out of a hot water heating system in the spring. The water in the system has been heated and the air has been driven out of it so that it will not cause rust. If you drain out the water the pipes will rust much more than if you let the old water remain in the system.

7. For ordinary household service the storage system of hot water supply is most satisfactory. The instantaneous hot water supply is adapted principally for use in factories where very heavy demands are made for hot water over relatively very short periods of time, at the closing hour, for instance, when all of the factory help are attempting to wash up at the same time.

8. The extra cost of all brass piping instead of iron piping depends entirely on the size of the house, the number of bathrooms, and so on. Over a long period of time the brass piping will actually pay for the extra cost in cash by saving plumber's bills—aside from the satisfaction of uninterrupted service.

9. If your house is heated by steam the most satisfactory hot water supply system is obtained by the use of a heater coil which transfers the heat from the boiler water to the hot water supply tank by means of a coil enclosed in a small tank, the tank being connected top and bottom to the boiler and the coil being connected top and bottom to the hot water storage tank.

10. Either the holes in the gas burner are too large or the air valve is set too far open so that there is an excess of air in the mixture. A partly clogged burner sometimes will act in this way.

A definite program for getting ahead financially will be found on page four of this issue.

How to Tame a Rough-Riding Car

(Continued from page 142)

work like springboards turned upside down. Along comes a bump—"protuberance" in your lingo—and pushes the wheel up and compresses the spring, and because the car isn't stationary and the bump is, the spring shoves the car up in the air. Then when you come back to earth you pull your hat off one ear and say, 'My, wasn't that an awful bump!'

"And if you slam into two or three bumps spaced just right on the road, you're likely to say something a lot stronger than that because the car will get to bouncing up and down till you almost go through the top. Traveling over rough roads in a car that keeps bouncing like a regular broncho lets ly gives you a pain in the neck. Your head wobbles back and forth so much."

"Most interesting!" observed Jason. "Evidently the phrase 'pain in the neck' has a dramatic physiological origin."

"YOU'D have found it out for yourself if your shock absorbers had got any worse and Gus. The main job of shock absorbers is to keep the springs from kicking the car up in the air. That's all the strap here to do. As the spring compresses, the mechanism inside the shock absorber pulls in the strap or flexible steel cable. Then, when the spring starts to expand again, the shock absorber pays out the strap or cable against a strong brake which slows down the motion of the spring so it can't shoot the car up in the air. One of your straps was broken and the others were so loose they weren't working right."

"Now I comprehend," said Jason. "A shock absorber is a contraption device operating only during the expansion of the spring. If that is the deterioration, obviously any type of auxiliary spring would not fix the requirements here as its action would be additive to the functioning of the main spring."

"You'll be, Jason smiled. "Quite a mouthful of words, but you've got the sense of it—and accurately, too."

However all shock absorbers aren't of the strap or cable type. A great many have a point arm hooked to a lever on the shock absorber. They work the same as the strap type to keep the spring from expanding too fast and they also act to prevent the spring being jammed against the frame when you hit an extra heavy bump. You couldn't get that action out of a flexible strap or wire cable."

"What is the procedure in adjusting shock absorbers?" Jason questioned.

"RULE of thumb, mostly," Gus stated. "Take the car out on a rough stretch of road and change the adjustment on each shock absorber until you get the car so it rides nice and smooth. One thing you want to watch out for is getting the absorber on one side tighter than on the other. That goes for either the front or back pair. If you do the car will have a cockeyed motion that's fierce. The trick is to have the adjustment as loose as you can and still get smooth riding."

By this time, Gus had replaced the broken strap and taken up the slack in the others so that the adjustment was approximately correct. "All finished," he announced. "I'll go out and adjust 'em for you or you can tackle the job yourself. How about it?"

"With your lucid instructions, I feel competent to attempt the work myself. Now if you will inject a supply of gasoline into the tank I shall be doubly indebted to you."

"That chap is no saphead even if he does waste a lot of good language," Gus growled to Joe after Jason had left. "Trouble is, if he ever gets up nerve enough to pop the question to that flapper, he'll wrap it up so much language she won't know what he's driving at."

Submarine Safety Devices Proved

(Continued from page 31

designs. In the Washington Navy Yard I became associated with the men who developed the present 'lung'—Chief Gunner C. L. Tibbals, Frank M. Hobson, and Lieutenant Commander G. H. Mankin. Also aiding were such divers as Chief Gunner Laughman, of *F-4* fame, and Chief Torpedomen Eiben and Kalinoski. We developed a number of experimental 'lungs,' but they were discarded after tests. We finally stripped all loose gear, such as oxygen bottles, air flasks, and reducing valves, and came to the type from which the new 'lung' finally emerged.

The first 'lung' was the one used in all of our tests up to 100 feet. This apparatus has a rubber bag with a 4,000-cubic-inch air capacity. The rubber is specially treated and constructed so it will not stag nor tear, and is protected against the oxygen and salt water. Inside of this bag is a small canister of a half pound of soda lime, which removes carbon dioxide from exhaled air and purifies it.

"TWO tubes leading from the top of the bag are fastened together at the mouthpiece. In a chamber on the outside of the mouthpiece are two mica disk valves, which guide the air through the left-hand tube when you exhale and the right-hand tube when you inhale. A valve near the rubber mouthpiece itself can close off the air and retain it in the bag for use as a life preserver after the user reaches the surface of the water.

"The rubber mouthpiece fits securely between the lips and is gripped by the teeth. A strap passes over the head of the user, another around the waist, and two lower clips attach to the clothing about the legs. A nose clip affixed and the wearer to breathe only through his mouth. At the bottom of the bag is a flutter valve which permits excessive air to escape and prevents water from flowing in.

"The first tests were conducted in a model basin at the Navy Yard in Washington. The first depth was about fifteen feet. All members of the experimental crew ran this test for about thirty days. The men were observed closely and their breathe counted. Each man would put on the apparatus, walk down a ladder into the water, and then move about on the bottom or just sit quietly for from two to six minutes. The doctor examined them after the tests and found them in good condition.

"The next step was to construct a diving bell. This consisted of a tub two and a half feet in diameter and eighteen inches high, open end down. Two uprights, leading down four and a half feet, were connected by a wooden crosspiece. The bell was ballasted by lead on the bottom of the uprights, and lowered into the water. The men making the tests would stand on the crosspiece with their heads in the air space inside the tube, and thus were able to breathe. Upon reaching the required depth, they would put on the lung and come out, slowly ascending a guiding line.

AFTER depths in the tank had been increased to the limit of sixty feet, we put our expedition on board the *Crilley*, an old diving boat, and went down the Potomac River to a point 110 feet deep. Eiben and myself went to the bottom by means of the diving bell and returned safely by using the 'lung.'

"Our next tests were made in Chesapeake Bay, off Solomon Island, in 135 feet of water. Here Eiben, Kalinoski, and myself were lowered in succession to 135 feet and made escapes to the surface. Still not satisfied, we obtained permission to use the submarine *S-5*, recommissioned as an experimental hulk, and had it towed to Key West, Fla., where we submerged her and made escapes from depths down to 200 feet. On board was a volunteer crew of picked men commanded by Lieut. N. S. Ives, and including Lieutenant Shagg, of the Construction Corps, and Chief Gunner Tibbals, a deep-sea diving expert. Escapes were made from the motor room, torpedo room, and engine room at various depths.

"In flooding the compartments, we first released the hatch at engine-hatch and admitted the water through a 6-inch flood valve operated from the control room. The men stood in the compartment waiting for the water to pour in. With the entrance of the water the pressure began to build up. The hatch began to leak, at first a few drops—a warning of danger—and then in a stream which increased until it was eighteen inches in diameter.

AS THE water rose the excessive air escaped through the open hatch until the height of the water was level with the bottom of the hatch skirt, which extended down into the compartment about three feet. It was necessary then to crawl up the ladder and throw the hatch wide open. Next a cork buoy attached to a small line was released, and it reached the surface. The line was made fast and the men were ready to escape.

On the buoy line every ten feet were wooden balls down to seventy feet, so that the men coming up could determine the distance they were from the surface. The men put on their 'lungs,' charged with oxygen, ducked under the hatch skirt, and followed the line to the surface. At the first wooden ball, they stopped for a short period to become accustomed to the change in pressure. Stops were made at each of the succeeding balls until the surface was reached.

I did not notice any difference in escaping from depths greater than sixty feet. The 200-foot escape had no more sensations than 100 feet, and I do not believe the men could tell, within reasonable limits, at what depth they were unless they could see a pressure gage.

"At the 200-foot depth, the water was very clear—a dark blue—and the light resembled twilight or starlight. Nearer the surface, say 100 feet, it resembled moonlight and the visibility was from twenty to fifty feet. As the surface was approached, it increased to sunlight.

"WHILE the fish in the vicinity of Key West are large and vicious, we did not experience any difficulty from them during the tests. Precautions were taken, of course. An oscillator was run at frequent intervals and a train of air bubbles was made to escape continuously from the submarine. We had been told that these two things would frighten the fish away.

"In all of our escape work with the 'lung,' oxygen was used for filling the bag. However, I believe the same results can be accomplished by using the air from the diver's lungs. We intend to continue experiments to determine to what extent oxygen can be eliminated. We have already made one test to 110 feet. It is generally known that the value of oxygen percentage increases in proportion to the atmosphere of pressure in which you are breathing. For example, ten percent of oxygen in two atmospheres of air will give the equivalent of thirty percent of oxygen, and five percent of oxygen under four atmospheres of pressure will give the equivalent of twenty percent oxygen. Consequently when the bag is inflated from the lungs, it receives air containing about seventeen percent oxygen. Of course, as this air is rebreathed, the oxygen percentage is lowered, but since the whole is under pressure, the effect of the oxygen is that of more than normal.

"Training in the (Continued on page 145)

Submarine Safety Devices Proved

(Continued from page 144)

use of the 'lung' is very simple. Present plans call for thorough instruction for every officer and man in the submarine service. A man once trained will never forget how to use the device any more than he will forget how to swim.

"The Bureau of Construction and Repair is taking steps to equip all submarines with the 'lungs,' two for each man and ten percent additional as spares. The two end compartments of submarines will be fitted as retreat and escape compartments and each will contain apparatus for the entire crew. Thus no matter where a submarine is struck or flooded, the men may retreat to the bow or stern toward safety. Of course, if the vessel is damaged in two places simultaneously, the men between those points will be in a bad way.

"Such an accident, especially in peace time, is barely conceivable.

"THE safety steps being taken by the department seem to put the submarine man on a par with the surface ship sailor. It is our belief that many of the past tragedies connected with the submarine service will not be repeated when the 'lung' and other safety equipment now being tested are placed on all underwater craft."

The use of pad-eyes was tried before the war and then discarded. The difficulty of connecting pontoons to float a disabled submarine, as shown in the *S-4* disaster, led to new pad-eye experiments.

"Tests are to be made with the *S-5* with four pad-eyes on each side. Use of these eyes, however requires a diver to go down to fasten hooks into the eyes. The hooks, attached to a chain or cable, are lifted by first sinking and then inflating pontoons. Experts agree, however, that outside diving and work with pontoons is next to impossible in rough weather.

The new marker buoys are to be fastened to the outside of a submarine, one above each compartment. They can be released from the inside and will float to the surface, carrying both a telephone cord and a light, and acting not only as a marker for rescue craft but as a means of quick communication with the trapped men.

THE new diving bell is capable of carrying four men at a time to the surface. It, however, must be operated from a surface rescue boat. A rubber washer on the inside fits snugly over the hatch cover and forms a water-tight compartment. Divers, also, are necessary to attach the bell every time it is lowered. All of these latter devices, however, are regarded as secondary to the "lung" in rescue work.

The compact and efficient breathing apparatus is to be the Navy's first line of defense in submarine accidents.

The urgent need for safety devices on all submersible craft was again tragically demonstrated a few weeks ago, when the British submarine *H-47* was sunk in the Irish Sea with twenty-one of her crew on board after a collision with the submarine *L-12* during surface maneuvers.

The hull of the *H-47* was rent by the impact and she went to the bottom with such speed that it is unlikely the crew had time to close the bulkheads of the water-tight compartments. Even if they had, water probably seeped through the packing around the many wire and pipe connections in the walls of the compartments because of the crushing pressure at 270 feet, the depth in which the submarine went down.

Since the war, eleven submarines have sunk, with a loss of 480 lives.

"80 Miles on a Gallon by 1939"

(Continued from page 145)

works out the best *theoretical* answer. He then tests it on the proving ground of *practical* value. If it stands this battering, he proceeds to manufacture his product as rapidly and cheaply as quality specifications permit.

He smiled at my amazement as I counted the words and found exactly fifty.

"You played right into my hands with that question," he remarked. "You see, I used to be a telegraph operator back in 1900 when I was studying engineering at Ohio State, and it was one of my little timesaving tricks to count the words as they came over the wire. If you'll look into the lives of many inventors and engineers, you'll find they served an apprenticeship either in telephone or telegraph offices. I worked in both, and also in an electric lighting plant before I was twenty-two.

"MY EXPERIENCE as an installation man in the old Star Telephone Company of Ashland, Ohio, helped me when I went into the research department of the National Cash Register Company. I'll explain how. As an installation man I'd been in enough small stores to know that the cash box was usually kept in a dark corner, or under the counter where no one could see it. The storekeeper had put it there, of course, so that thieves couldn't locate it so easily. Well, you know the psychological effect of putting a thing in a dark corner. It encourages petty pilfering on a large scale. So when I went to work for the National Register people, I determined that if I couldn't make the storekeeper bring his cash box out into the light, I could bring the light to the cash box.

Encouraged by E. A. Deeds, general superintendent of the company, I went to work on a series of electrical devices calculated to make the cash register a more practical and foolproof machine. Finally, I arranged things so that electricity illuminated the dial, rang a bell, and printed a small slip every time a sale was rung up. Which added just the features of publicity that we wanted, for the protection of both merchant and customer.

Meanwhile I had rigged up a small workshop in Mr. Deeds's barn, and I spent all my spare time experimenting with a tiny electric motor, trying to determine just how much work it could do. That's the key test for the research engineer, and I never allowed myself to forget it. I kept saying, 'There is power, heat, and light in this little motor. How can I turn these forces to practical value? In other words, how can I put them to work?

"ONE day a friend of mine broke his arm cranking his automobile. That was in 1908. There were plenty of broken arms in those days of balky motors and hand cranks. Motorists were sometimes tempted to go back to the horse and buggy, due to the constant danger of cranking automobiles—to say nothing of the inconvenience of climbing out into the mud every time the car had to be started. So it occurred to me that the most-needed thing in the motor world at that time was a self-starter. I went to work to supply that need, putting my faith on the sturdy electric motor on my workshop bench.

"I got a few good breaks. A great break occurs when you hack your way through ninety-nine strands in the cable of difficulty, and then circumstances step in and break the final strand for you. I devised a starter strong enough and dependable enough to turn over any four-cylinder engine, but I ran into my final difficulty when I came to look for a place to gear up my starting motor to the crank shaft. I first tried it on the front end of the shaft, but that forced me to do away with the hand crank, which couldn't be so easily sacrificed in those uncertain days. For a long time I didn't know

(Continued on page 147)

"80 Miles on a Gallon by 1939"

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where to put my starter. Then one night, as I wound up my eight-day clock, I noticed that the impulse from the winding key wasn't transmitted directly to the mainspring, but passed through a series of lateral cogs. That idea simmered in my head overnight, and when it had all boiled down next morning I knew pretty much how to solve my problem.

"I merely cogged the outside rim of the flywheel (all flywheels had been smooth up until this time) and shoved my self starter right up alongside it. Then I turned on the juice and let my starter wind up the motor—from the rear end of the crank shaft instead of the front end. You may be interested to know that neither the position nor the basic principle of the self-starter has been altered from that day to this. Improvements have been made, of course, but the fundamental idea is the same as it was in the beginning.

BUT I hadn't yet exhausted the possibilities of that little motor on my workbench. I figured that if it would provide power, it would produce light—portable light, that could be used in rural districts still dependent on kerosene lamps. Here was something practical indeed, something that would bring increased pleasure and efficiency to millions of people. I know, because I was born and raised on a farm. So I went to work on that problem, and the result was the Delco lighting system, a portable electric lighting plant of very moderate cost. Mr. Deeden and I began to manufacture these portable plants, and there are over a million of them doing valiant duty in rural communities right now.

"By this time, as you can readily imagine, I was mightily interested in the electrical problems surrounding the automobile. When I joined the General Motors staff in 1916 I saw that the various electrical aspects of automobile engineering—ignition, starting, lighting, etc.—which were separate units up until then, could be contained into a single unit. How convenient and practical it would be, I figured, if all the electrical factors in an automobile could be concentrated on the dashboard, and controlled by a single switch! That idea was the beginning of the Delco system, which is now standard equipment for all General Motors cars. But say, let's talk a little more about the automobile industry in general, and not so much about my individual self.

I KNEW it was going to be difficult to ask Mr. Kettering a general question about automotive science without involving him personally in the discussion. One might as well leave Edison out of the story of electricity as avoid Charles Kettering's name in the epic of the automobile. Remembering his fondness for big questions, however, I determined to give him a pass.

"What do you consider to be the single greatest step forward in the science of automobile manufacture," I asked him, adding with a grin, "and what is your connection with it?"

Well, he began, I think I'm going to surprise you. Perhaps you imagine that I'm going to answer you in terms of specific inventions—four-wheel brakes, balloon tires, or eight-cylinder motors. But I'm not, for I seriously think they do not rank in importance with the big step General Motors took in 1919 when it decided to establish a series of 300 practical and uniform tests for every automobile leaving its factories.

It was a radical and expensive step, necessitating the building of a huge proving ground and the invention of several delicate instruments to tell us what we wanted to know about our cars. Heretofore if we wanted to know how well a car could perform on a steep grade we had to take it to

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Pike's Peak or Mt. Washington. Since no two cars were ever tested under *identical* conditions, the automotive industry had no absolute standards to go by. We decided to establish these standards, and bought a thousand-acre tract equidistant between Detroit and Flint, so that we could have all the room we needed to move around in.

"On this proving ground we first built roads of all types—gravel, concrete, dirt, Tarvia, and just plain mud. We built a four-mile speed-lap, the fastest in the world, on which our stock cars can attain a speed of 100 miles an hour. Our two-mile straightaway is level to 0 degrees, and we have artificial grades as high as twenty-four percent—much steeper than Pike's Peak. One section of the proving ground is known as the Mud Hole, through which we drive our cars in mud up to their hubs. From the Mud Hole we shoot the cars into a refrigerating room where men work in fur coats, test up engine performance at several degrees below zero. We test the 'deceleration' or braking speed of the cars, both on the road and in the laboratory—and it was as a result of one of these deceleration tests that we decided to put four-wheel brakes on our products. Two-wheel brakes are now as obsolete as muzzle-loading shotguns, thanks to our scientific tests which proved that no two-wheel brake could stop a speeding car within the required margin of safety in modern traffic.

"DELICATE glass burettes, reading to half a cubic centimeter, register fuel consumption under all kinds of conditions. A duplicate steering wheel measures to a fraction of an ounce the steering energy required. Every axle, spring, and forging is specially tested for tensile and shearing strength. Even the breaking point of glass has been discovered, and as a result of these tests we are now perfecting a flexible, nonshatterable windshield glass of our own.

"In all these tests we permit only a minute variation from specifications, so small that you might as well say that it is nonexistent. On ordinary parts this variation has to be under 1/250 of an inch, on bearings and all moving parts of the engine, it has to be under 1/1,000 of an inch. In this way we get a marvelous uniformity which makes for performance, of course. If any part, or any assembled car, can't stand the beating we give it on the proving grounds, back it goes to the factory—sometimes even to the designer, to be worked over until it can meet our tests.

AT THIS point I interrupted with a burning question.

"Isn't it a pretty expensive process?" I asked.

"Not in the long run. We've figured out that it costs us about thirty-two cents per car to test the total number of cars passing through our factories every year. And see what it saves us in mechanical 'flops' and loss of prestige. For instance, we had a car in 1921 that was termed by a dozen experts as the 'car with the perfect motor.' Theoretically it would do everything that automotive engineers had ever dreamed of. It was so good on paper that I had my suspicions. Before putting it on the market, I persuaded the company to let me give it a special series of hard-boiled tests. I took that 'perfect motor car' to the proving grounds, and gave it a year's wear made of two weeks! Four merciless drivers pushed it over all kinds of roads for twenty-four hours a day, and before it had gone 30,000 miles it was a total wreck. In the blueprints it looked like a perfect car, but it broke down under the rough and tumble abuse of everyday usage. So without a shade of regret we had it scrapped. In that instance alone, the

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proving grounds more than paid for itself by saving us the loss of a whole year's output."

Thus far Charles Kettering had been telling me about the negative and critical side of his work. I wanted to know something about the constructive experiments he had been carrying on for General Motors. With a direct question I prodded him into relating one of the most revolutionary experiences that ever took place inside an automobile factory.

"Isn't there a story about the invention of Duco that concerns you pretty closely?" My query started a train of fast-moving reminiscences, and soon Charles Kettering was telling me the story of Duco, as romantic a yarn as ever came from the lips of an engineer.

"YOU mustn't think that I invented Duco," he began. "I merely saw the necessity of a superlacquer for automobiles, and kept hammering at the notion, until Dr. C. M. A. Stine and his chemists in the Du Pont laboratories got busy and actually produced it. It happened this way. We were speeding up production all along the line, and had managed to clip about three days off the total production time. We thought we were doing wonders until we struck the paint shops. It may surprise you to learn that before 1924 it took thirty-one days to turn out a first-class paint job. It was generally believed by body painters that they couldn't possibly turn out a gleaming finish in less than a month. I remember my conversation with the head of the paint shops.

"'A month to paint a car! Nonsense!' was my first comment. 'Suppose we agree that hereafter it's only going to take a day!'

"'Paint a car in a day! Why that's impossible. It takes almost a day to put the first coat on, and then it has to dry for forty-eight hours.'

"'Why not use a lacquer that dries in a minute?' I suggested.

"The body painter shook his head, eyeing me warily as if I had suddenly gone mad.

'Lacquer like that would stiffen on the brush before we could get it onto the car,' he objected.

"'Then let's invent a special lacquer and blow it on with an air brush. We've got to cut down this car-painting time by ninety-five per cent, and that's that.'

"I OUTLINED the problem to Dr. Stine, and in a few days he was way ahead of me in the matter of painting cars. After an epic struggle, which I believe has already been recorded in POPULAR SCIENCE MONTHLY, he evolved Duco—the hardest and glossiest finish that was ever put on any surface. We tested it with fire, water, acid, and cold chisels until we were positive we had the paint we were looking for. And how long do you suppose it takes now to paint a whole car, from hood cap to rear fender? Just one hour! Which proves, among other things, that both the boss painter and myself were way off in our calculation of the time it takes to turn out a perfect paint job.

At this point a long-distance telephone call from Detroit interrupted our conversation. The chief chemist at the General Motors Proving Grounds evidently had run out of inspiration on the flexible glass problem, and was calling up 'Ket' to get a new handful of ideas. 'Ket's' advice consisted of a long string of chemical formulas that would bewilder anyone but a glass expert. I was amazed by this man's familiarity with the chemistry of glass, and expressed myself warmly on the subject when he hung up the receiver.

"'An automotive engineer has to be a chemist, nowadays, as well as everything else,' was Mr. Kettering's comment. 'I've never estimated how big

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a percentage of my problems are chemical in their nature, but I suppose it's something like seventy-five percent. The chemistry of steel, glass, rubber, and gasoline has to be at the engineer's finger tips. And speaking of the chemistry of gasoline, let me show you how we improved motor fuel and at the same time solved one of the most baffling questions that ever confronted us—all by means of chemistry.

"As you know, the cylinder 'knock' was for many years among the most annoying problems to car owners, as well as motor designers. For a long time we thought the knock resulted from defective cylinder construction, worn piston rings, or loose connecting rods. By improving engine construction, we ruled out this possibility. But still the knock could be heard under certain conditions, and I was becoming more and more convinced that the knock was a chemical, rather than a mechanical, problem. So I turned my attention to the chemistry of gasoline. I began to wonder if there wasn't something that could be added to gas to make it more 'digestible,' more completely explosive, for it was fairly well proved by now that the knock was due to imperfect combustion in the cylinder.

"WELL, I got together with our engineers and we tried everything in the table of elements. Iodine, aniline, selenium, tellurium—we mixed them all with gasoline in the attempt to remove the knock. After a year of experiment, the engine still knocked, and we had pretty well exhausted the list of elements that would combine with gasoline. At last, I suggested lead, which is about the last thing in the world chemists would ordinarily regard as helpful. We added a fluid compound of lead to our gas—and it knocked worse than ever.

Then I had a real inspiration. Knowing that strange things happen in chemistry, I decided to reduce the proportion of lead from one percent to half of one percent. A slight diminution of the knock was noticeable. Then I reduced the lead compound to a third of one percent—and the knock disappeared entirely. The resulting mixture was Ethyl gasoline, a fuel that is fifteen percent more powerful than ordinary gas, and positively without a knock in a tankful.

I NOTICED some airplane designs on Mr. Kettering's desk, and remembered that he was the inventor of the ignition system in the Liberty motor and had made nearly 3,000 engines for the Government during the war.

"Kett" was one of the first men in the United States to fly with the Wright brothers, and was one of the organizers of the Dayton-Wright Airplane Corporation. Right now he is a director of the Pratt & Whitney Aircraft Company, and chief advisor to General Motors on all matters pertaining to aviation.

"Of course General Motors is going into the aviation game," he said emphatically, in response to my question. "We'd be slipping back into the Middle Ages if we didn't have a complete line of airplanes for the public to choose from. As a first step we have acquired a forty percent interest in the Fokker Aircraft Corporation of America. Our exact plans are still in the tentative stage, and I'm not at liberty to announce our complete program. But if you come back inside of twelve months, you'll hear our propellers whirring, so to speak—in all sorts of sharps and flats. We're going to have a big line, ranging from dainty butterfly planes to giant three-motored transoceanic liners. 'A plane for every purse'—that's all I can tell you of our plans just now."

"But how about the automobile business? Isn't it going to meet some terrific competition from the airplane, as a means of transportation?

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"It certainly is, and I'm glad of it," smiled Ket. "Remember the thousand-dollar, thousand-pound, hundred-mile-an-hour automobile I predicted at the beginning of our conversation? Well, the airplane is making that a reality of the very near future. Without pressure from aviation, we motor manufacturers probably would loaf along just as we were doing until the airplane came along.

"Take this matter of a car's weight, for example. Until 1920 we used to boast of how heavy our cars were. Now, one of our chief selling points is how *light* they are. Lightness of construction is something we learned from airplane builders who utilized newer and lighter metals in their planes. Aluminum, lynite, and invar all came into automobile construction by way of the airplane. And right now we are perfecting, for commercial purposes, a new metal fifteen times stronger than nickel-steel, yet only one third as heavy as aluminum. We figure that we can allow about four pounds per horsepower in making motors of this new metal. Thus a fifty-horsepower motor would weigh only 200 pounds! See the possibilities? If we can make a lighter chassis, and an engine which, in proportion to its size, is much more powerful than the gigantic masses of steel that used to be under automobile hoods, you can see why we are going to need less gasoline. This fact, together with improved methods of carburetion, is going to double the mileage we can get on a gallon.

"I ALSO believe that many parts will be eliminated in the automobile of the future. The whole method of gear shifting is undergoing a series of changes right now—changes that will eventually do away with the cumbersome shifting lever. Shifting, braking, and possibly steering will eventually be a part of the electrical system, just as starting and lighting are at present. Body design is due for marked changes, also. We are only beginning to learn the possibilities of the streamline body in reducing wind resistance. Major Segrave never would have made his record record unless he had thoroughly understood the science of streamlining.

"Then you envision the automobile of the future as a simpler, lighter, better integrated conveyance, highly electrified, and constructed with great attention to streamlining and lowered wind resistance?

"That's about it," agreed Charles Kettering. "As I see our job in the future, it's this: In order to keep up with a fast traveling aerial-minded public, we've got to raise the standards of motor car manufacture to the point where a person will have to take to the air if he wants to travel any faster or smoother. And when he leaves *terra firma* we want him to say: 'The people who made my motor car did such a good job that I'm sure they know how to make good airplanes, too.' Which will be true.

"AS FAR as I can see—and I'm taking a long look into the future—the airplane and the automobile will never conflict. Instead, they'll complement each other—and inside of another ten years it'll be a wise man indeed who can tell, when blindfolded, whether he's riding in a plane or a car."

NEXT month: "What's Ahead in Radio." The inside story of modern broadcasting, told by Frank Parker Stockbridge in an interview with the man who has helped to place better radio programs in the homes of millions of Americans.

"Old Salts" of Fresh Water Seas

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coming down—ore from the Minnesota iron pits, wheat from the Dakota and Manitoba prairies.

It was like sitting on the driver's seat of a truck in a double stream of fast traffic on a sharply angling road. Never in all my salt water wanderings had I seen ten gales like it. But our captain was as calm as if he had all the Pacific around him.

"Steel Trust boat! That's the fellow that tried to push over a lighthouse in the St. Clair River last spring—" so ran his comment on the passing carriers—"there's the fellow that tried to cut me in two in the fog up in Whitefish Bay last trip. get over there, damn you! I'll take my share of the road.—Port a half. Two. Steady! keep her on the buoy.—What's that fellow trying to do, cut across our bows?"

"ALWAYS he referred to the other vessel as 'that fellow.' It seemed quite natural. Lake freighters have few of the graces of salt water craft. There is a bulging masculinity about them, and almost always they bear a masculine name.

There's the *Harry Coulby*, molding to a big hulk. biggest ore-carrier on the lakes under the American flag. Pickands-Mather boat, 630 feet long. She made a swell record a few weeks ago. "What was that, Jake?" the skipper glanced toward the mate, a rusty salt named Tucker.

"I handled 14,300 tons of ore in Ashtabula in six hours from the time he passed the lighthouse inbound till he headed out," the mate replied, as if jealous of the feat. Then smiled bitterly, glancing at me. "I ought to see the guest cabins on *that* boat! Paneled in teak wood! Just like a yacht!"

Great Lakes parlance uses "boat" instead of ship. "unload" instead of "discharge," but these landlubberly terms are offset by the fact that the unsalted sea, owing to the traditional company terms, while salt water, at least on American ships, has gone over to the use of numbers for compass points, from 0° to 360°.

"I'm going to take another trip in ore," says the captain. "then jump into wheat. We've had a starvation rate on wheat up to now this season, but in another week or so I expect it'll jump to four cents, or four and a half.

THE backbone of lake freighter business, I learned, is iron ore. Wheat is a seasonal trade down lake, coal an intermittent trade up. But no fleet can live on them alone. It must have ore. The biggest owner in the lakes, the Pittsburgh Steamship Company, is a subsidiary of the U. S. Steel Corporation. Its hundred ships handle two thirds of the 25,000,000 tons of U. S. Steel ore that comes down the lakes each season. The second largest fleet, Pickands-Mather, with half a hundred carriers, is also tied in with ore fields and smelters. But some of the smaller fleets, with no such connections, are having a harder and harder time getting business, our captain explained. "So here on the lakes, as in all other fields of business, one sees the gradual disappearance of the small unit—merging of the little fleets into the big.

As we swung around a wide bend and came in sight of Detroit, the chief engineer, who had come up into the pilot house, exclaimed:

"Here comes the finest boat on the lakes!"

The vessel plowing down toward us had a look of glittering newness. She (or rather her) bore the name *Carl D. Bradley*.

"Latest ore carrier," said the chief. "Turbine electric drive."

"Are there many of them on the lakes?"

"Not many yet. But they're coming. Automatic stokers, too," he said admiringly. "They say it cuts the

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A definite program for getting ahead financially will be found on page four of this issue.

"Old Salts" of Fresh Water Seas

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coal hill a fifth, and in some cases more."

"Any Diesels here on the lakes?

"Not many—at least on the big boats. You see, Diesel oil costs about three times as much as coal up here. So it can't compete.

As we came opposite the city, a fleet motor boat leaped out from shore, heading diagonally for us. Out from the captain a cabin someone had brought a small box. Into it the mate shoved a bundle of letters, and he carried the box amidships. There a deck hand attached the box to a rope, and lowered it overside. The motor boat darted alongside, the man in the boat snatched it, emptied it, stuffed some letters and papers into it, swung away and sped toward shore. The Detroit Marine Post Office works quick and snappy.

AT DUSK we were plowing northward in St. Clair Channel with the same assurance. Yet almost every turn suggested to the captain or the mate some mechanism of navigation. Here was where one night they had come upon the *Wolf* all afire and her crew jumping over the bow. Here was where they'd seen a boat of the Buffalo Steamship Company sink in a head-on collision. And as we passed the lights of Port Huron and steamed out into black Lake Huron, the mate said sourly: "Here's where the *Price* turned bottom side up!"

The following forenoon I saw a strange thing. We had been running through dense fog, blowing our whistle at regular intervals. Whether there were other vessels near, we did not know. We heard nothing. Suddenly, the fog lifted. The sun streamed down. Half a mile away, on our starboard beam, was the silhouette of a freighter, still enveloped in fog. We could see steam rising at intervals from her whistle, yet not a sound reached us. That area I envisage of fog completely smothered it.

That incident brought learns of stories from mates and wheelsmen and captains—stories of collision between fog-bound boats both blowing their whistles yet unable to hear anything, and of vessels running on rocks in snowstorms because the snow smothered the sound of fog signals. Snow is worse even than fog, it seems, in cutting off sound.

THEN Anson, the tall black-haired wheelsman from the Beaver Islands, told the tale of his terrific experience on Lake Superior on the *Fontaine*—how they battled a northeaster for three days, holding up along the North Shore to avoid islands and rocks, ice coating the pilot house windows so that they could see only through a small hole in the center window kept melted with rags heated on the steam radiator. The wrenching of the gale sheared off so many rivets in the ship's bottom that there was twelve feet of water in her hold, and when she finally fought her way into the shelter of the Soo River, she sat so low that her anchors were under water. Then followed the tale of how the *Turret Chief* was hurled onto the rocks of the Keweenaw Peninsula, in a freezing gale in the early hours of dawn; how the crew crawled out on the rocks and wandered through the woods half-naked till they found shelter in a deserted shack, where they huddled three days foodless till the storm went down.

Late that night we came to Sault Sainte Marie and the four locks of St. Marys River which link Lake Huron with Lake Superior. The three American locks were full of boats locking down, so we steered for the Canadian lock.

Here was the essential lifeblood of America, iron and wheat, pouring down through this narrow gap toward the blast furnaces and baking ovens in the heart of the nation.

Wouldn't salt (Continued on page 13)

"Old Salts" of Fresh Water Seas

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water men who dismiss the lakes contemptuously get a shock if they know that the tonnage of iron ore that came down these locks last year was more than all the tonnage both ways in Panama and Suez *combined!*" groaned our skipper.

Always I found the undisguised contempt of salt water folk rankling in the skipper's mind. Later on, when we were crossing Lake Superior he said: "During the war some of them salt water captains came up here to carry wheat down to Montreal. One of 'em loaded at Port Arthur in stormy weather. Somebody warned him he'd better wait a spell till the weather blew over. What, he says, let this weather boss me up? This is only a mill pond. Well," the skipper's eyes gave a glint, "he left port and was never seen again."

AS WE steered out into the clear, cold moonlight of Whitefish Bay, and the mate strode back and forth, a ghostly figure in the eery black pilot house, giving the wheelsman orders in short sharp words, he told me the story of Captain Neale, certainly one of the strangest of all seafaring history.

It was not far from where we were at the moment that Neale in his ship *Myron* was heading down the lakes with a cargo of lumber towing a large scow lumber laden. Encountering a savage gale Neale saw that his barge was making. He dropped back alongside and took the barge crew off. A little later as the sea grew rougher Neale realized that his own vessel was doomed. Just as he put his head out of the pilot house window and shouted to the crew to take to the boats, a giant wave tore off the pilot house and carried it and the captain away into the mountainous seas. The men launched the boats and got away a few minutes before the *Myron* went down. Another steamer, the *Adriatic*, which had heard the *Myron* blowing distress signals, came running down with the wind and tried to pick up the boats, but failed. None of them was ever seen again. Either they were swamped in the heavy sea or else the floating lumber from the barge knocked them in. Twenty hours later the *Frank* spied a pilot house bobbing on the waves near Parisian Island. To it clung the stiff body of a man. The *Frank* came alongside and took him off. Neale was almost dead, but he was thawed back to life.

GREAT LAKES navigating officers "box the sun." This was impressed upon me the following day as we pushed westward through the foam-capped rollers of Superior. Navigation out of sight of land is by compass and clock—dead reckoning. Of course sometimes queer things happen. A certain captain ran full speed upon Chicago breakwater in the middle of the night because he happened to have two clocks in the pilot house, one set Central time and another set Eastern time, and he was watching the wrong clock. Sometimes the compasses get queered. Certain cargoes throw them off—steel rails, for instance, or an electric hoist working on a dock alongside. One freighter almost ran on the rocks because a passenger had carelessly left a wet umbrella standing beside the compass. Then there was the *Tioga*, which ran onto a sunken crib in Duluth Harbor and had to have some plates riveted. The captain left port and in thick weather ran smack onto Eagle River Reef. The riveting had thrown his compasses off half a point, which, in the 192-mile run from Duluth to the top of Keweenaw, set him twelve miles south of where he thought he was.

"But," criticized our skipper, "he ought to have used a sounding line in thick weather. He piled up with a dry sounding line."

Severe condemnation crackled in his voice.

In the St. Marys River and other restricted waters there are "range lights" to mark the channel, and always when a vessel passes through such a channel where the course between ranges is known, the mate checks the compass in order to see if any deviation has occurred.

Until we rounded the Keweenaw Peninsula—that rocky copper-veined finger of Michigan that thrusts up northeasterly into Lake Superior—the wind was brisk from the west. But as we shifted course off Eagle Harbor to WSW ½ W for the run down to Duluth, Minn., in the southwest corner of the lake, the wind swung into southwest and whipped up to a gale. Soon seas were crashing over the bow and hammering the pilot house windows with cold spray. But the captain ordered the chief to pump some more ballast water into her tanks, and drove on ahead.

AT NIGHTFALL we saw the red and white flash of Devil's Island Light and shifted course half a point to the southward. On we drove through the night. The seas hammered that empty ore box like sledges on a boiler. I went to bed. But not to sleep. There at times I thought I was going to be catapulted out upon the floor. But on we drove.

In the morning, peering through flying spume, I spied ahead a dim shore and a strange framework overarching a narrow gap in a point of sand. "That's the Duluth Aerial Bridge," explained the mate. We headed straight for it. As we passed under it, between two stone piers, the mate pointed to the right-hand pier. "There we—" he shouted. "There's where the *Matanzas* piled up and most of her crew froze to death in sight of all the folks in Duluth."

Shooting through the gap, we were suddenly in the calm of Duluth Harbor. To starboard were the streets of the Zenith City, climbing a steep bluff to meet the coal docks and grain elevators of Superior on the Wisconsin shore.

We swung to port, went through two bridges into the inner harbor and edged in. The lee of an ore dock, a long high trestle stabbing out into the harbor from shore. A switch engine was just backing a long string of ore cars, from the ore pits up in the Mesaba Hills, out upon the trestle. As the train came to a halt, men ran along it loosening the collapsible bottoms of the cars. The ore streamed rumblingly down into the ore pockets.

ALREADY our deck hands were stripping off the tarpaulins. The donkey engine began moving the hatch covers back against the rail. The moment we came alongside the dock, long spouts swung out from the trestle, centering over each open hatchway.

"Let her go!" yelled a voice. Red ore began spouting down into our gaping hold.

"Come on," said the captain.

I scrambled after him down a ladder in the rain, out through the dock to a taxi waiting there. We whirled uptown. He popped into the company offices while I waited outside. Then into another office. Then he came forth and we dropped into a cafeteria on Superior Street for coffee and rolls. The skipper glanced at his watch. "Well," he said, "I guess they must have 12,000 tons in her by now." We taxied back to the dock and climbed aboard. The spouts had swung back. Men were closing the hatches and clamping on the tarps. The skipper mounted to the pilot house, pushed his head out of the window, and barked: "Cast off!" The telegraph jingled. We backed out into the harbor and headed for the open lake.

We were off again with our box of ore—ore for bridges and motor cars and airplanes and printing presses and looms—red ore, the life-blood of the nation.

Motorless Plane Climbs a Mile

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Other experimenters, Pilcher in England and Chanute and Montgomery in America, carried on the tests that led to the Wright brothers' first flights in a powered airplane. For nearly twenty years after its appearance, motorless flying was neglected. In 1911, Orville Wright took his English friend, Alec Ogilvie, for a vacation at Kitty Hawk and hovered in a biplane glider for ten minutes. So little interest was there in gliding, however, that his feat stood as an American record for seventeen years and as a world's record for ten.

It was at the 1922 international meet in the Rhoen mountains of Germany that the modern "gliderflyer" came into his own. Martens in a "Vampyr" machine made the first flight of an hour. Hirtzen, a young student, mounted to a height of a thousand feet in a howling gale and soared for three hours and ten minutes. A. H. G. Fokker, now designing planes in America, flew with a passenger for thirteen minutes. Later in the year, French experimenters journeyed to the Sahara Desert, where they used the heat waves from the hot sands to lift their soaring planes. From then on, improvements in design and construction have produced machines and records believed impossible a decade ago.

IN THIS advance, accidents, as well as painstaking laboratory study, played their part. For instance, a crash once led to a new design. A pilot smashed the nose of his machine against a hummock in landing. Instead of sending it back to the factory, he patched up the hole, pasted canvas over it, and took off again. The machine flew better than before! The shortened fuselage and altered shape was just what it needed!

Recent reports tell of a new German mystery soarer, as yet unnamed. It is lighter than the Darmstadt, the record-holding sailplane of last year, and can hang in breezes only a third as strong as those required to keep other machines aloft. This marks an advance toward the goal of all glider designers—a machine that will soar in still air. Two of the mystery machines are coming to America. They will be flown at Cape Cod this year.

And what of the future? Will gliding ever be more than a sport? While it is unlikely that gliders ever will compete with powered planes, they undoubtedly will supply increased knowledge of air currents and contribute toward refinement in airplane design. Perhaps, also, in the realm of aerial photography and radio, the soaring machines, free from vibration and noise, will be put to use. As preliminary training for flying students their value already is recognized by German flying schools.

AT ANY rate, as a thrilling sport motorless flying is here to stay. The famous statistician, Roger Babson, even predicts that the little boys and girls of tomorrow will fly around their lyards in gliders with as much safety as the children of today play in their sand piles!

Crystals of the Movies

THE apparently smooth gelatinous substance on one square inch of sensitive motion picture film is composed of more than a billion silver bromide crystals varying in size and shape. Measurements of the crystals have shown that the gradation of light and shade in a movie is due to the wide range of crystal sizes in the negative film used in the camera, while on the positive film, containing the printed pictures projected on the screen, the grains are much more uniform in size, giving sparkle and life to the pictures.

Learn to Fly with Larry Brent

(Continued from page 40)

behind me was the practice field. I could see Randy standing there all alone in the middle of that big field. On top of him was a white spot. That was his face. He was looking up. I have often wondered what goes on in the mind of an instructor, standing as he was that day, looking up at one of his students on his first solo.

What went on in my mind was certainly different from what I had expected. I am not soft-boiled, and maybe it is unwise to say what went on in my mind, but as this is an honest record of my sensations and emotions while learning to fly—here goes! If it sounds gushy, I'm sorry. I wasn't merely thrilled at being up there alone, I was exalted. I felt like yelling and singing. Down there were people—stupid, earthbound people, crawling like ants about their tasks; up here was I, a master of the air, flying through space, my own hands and feet taking me where I wished.

I HAD had a sensation like it only once before—during my third lesson, when I suddenly stopped being scared of flying and really began enjoying it. Not that moment nor any moment I have ever known could compare to the exultation I felt on my first solo. It will probably never come again, unless some day I make a sensational loop across an ocean. I understand that Lindbergh's first sight of and when he flew the Atlantic was the biggest kick he ever got.

The first few minutes of that flight were worth all the sacrifices I had made to take up flying, worth all the hard work I had put into it. Soon now, I would be doing this for a living, flying the mail!

In the midst of these exalted thoughts, it occurred to me that I had to bring this ship back to land. It was worse than waking up from a beautiful dream. I had not yet learned to like landings. I looked down. There was Randy on the practice field, still looking up. My altimeter read 1,100 feet. It was time to cut the motor and start my glide.

My stomach warned me—but we were in a fight before—when I began my approach. I maneuvered for a position from which to start my glide—but I was not to cut that gun. Suppose I leveled off too high or too low. Suppose a side puff of wind struck me the moment before landing!

I MADE another circle. Then grimly I cut the gun. My stomach shrank and objected as the wind began whistling in the wires. The pitch sounded wrong. I tried other gliding angles. I picked the imaginary line down the center of the field. The earth came zooming up at me. Was I overshooting the field? I thought so. This proved to be an error of judgment.

I went into my glide. Randy said later all right. Then I changed my mind about it. I put the nose down. The whistling struck a higher note. I knew I wasn't doing it properly. In the few seconds that remained, I asked myself how I had done it before. I had been making some fine landings!

Suddenly in the front cockpit to pull me out of trouble now! "Sit her down, Larry. Keep 'em, Larry!" Sweat was running down Larry's face.

I leveled off. The wires did not stop whistling. The wheels touched. I wasn't up we went in a bounce. Randy called it forty feet. It looked nearer a hundred to me.

Fortunately, I hadn't lost flying speed. I slapped on the throttle and climbed again. Now I was scared. My throat was dry. My heart was hammering. And that lame duck of a stomach was doing a tail spin. I circled around and at 500 feet cut the gun and put my ship into the glide.

Again I leveled off too soon. Again I bounced and again I gave her the gun. As I started around that circle again, I thought of the story of the oiler at a naval training station in the war who had made bounce after bounce—a dozen of them—until a disgruntled mechanic on the ground finally exclaimed: "Somebody bring out a machine gun and shoot him down!"

My third attempt at a landing was a pancake. I rolled to a stop, wiped the sweat off my face, and started taxiing back to the end of the field as Randy came running toward me. I was sore and disgusted.

I settled down in my seat, jammed on the gun, and took off again. This time there was no thrill. And this time I wasn't rattled. I made a long climbing turn and, at 600 feet, faced into the wind with the field below me. Again I cut my motor and went into my glide. The whistling was on the right note. I began leveling off. Watch that left wing. Gently I pulled the stick back. And gently I sat her down on three points!

Well, I had soloed. I wasn't a rookie any longer. Randy climbed into his cockpit and we flew back to Curtiss. A few more lessons with Randy aboard, and I would be turned loose—forever. Randy made no comment on my solo flight. But he told me that he was through instructing.

AS SOON as I've graduated you, I'm through.

Why?

"I like cross country flying better.

"Is instructing too much strain?

Maybe.

"Is it too nerve-racking?

"Maybe.

That was all he would say about it. And his decision answers certain people who have said that these articles have been giving Randy a lot of nice free publicity and should bring him flocks of students. Take my word for it. Randy isn't instructing any more.

In concluding this article on my solo, there is another group of sensations which I may not be omitted. These were the sensations I experienced that night. I went into New York and blew myself to a dinner in a big hotel. Celebration! And suddenly, for some queer reason, I hated everybody in that dining room. I can't explain this, but it happens frequently to students in the solo stage. I wanted to leap up and punch my waiter in the nose. I didn't want my fine expensive dinner. I wanted to be up in the air, flying alone. I wanted to be out at the field with the smell of the dust and the gas fumes in my nose.

THAT feeling did not pass until my meal was almost finished.

Another curious reaction to my soloing is the painstaking care I have begun to take in everything I do, not only in the air, but everywhere else. I can't stand seeing one of my vest or coat buttons unbuttoned. My room at my boarding house used to look as if it had been hit by a cyclone. Since I began to solo, it has become a model of neatness. So have I. Sometimes I give myself a great big pain, so neat, so orderly, so finicky have I become.

My future plans, if you're interested, are as follows: As soon as I have secured my private pilot's license, I'm going to Florida. I am going to take some lessons in flying boats. I will also do some cross-country flying down there, as I understand that good planes can be rented very reasonably at many Florida airports.

I'm going after those 200 hours tooth and nail. It won't be long now!

THE END

NEXT month: "Barnstorming with Lindbergh," by Randy Enslow. A great pilot's own story of the days when he and Lindy shared adventures. Better order your copy early.

How to Choose a Heating Plant

(Continued from page 78)

and advantages and disadvantages seemed to be rather evenly balanced. He remembered that the first salesman had said that choice was largely a matter of opinion, and went back to see him and to hear his recommendation.

"If you're pressed for money," said the salesman, "use one-pipe steam, and if you're not, put in vapor-vacuum. In either case the size of the heating plant will have to be figured, as I've marked your plans with the number of feet of radiation you'll need for each room."

"Number of feet of which?" asked Bob, puzzled.

"Of radiation. It's a way of saying how much heat each room should have. You figure the size of a room and the number of square feet of exposed wall and glass that it has, and then you consider its location. If it's on the exposed side of the house, it'll have to have more heat than if it's protected, and a downstairs room will need more heat than one upstairs. There's a formula that tells the size radiator you'll need for each room. Add together the radiation figures for the different rooms and you'll have the size of the boiler required. But I've learned by experience to recommend a boiler a size or two larger than what the figures call for. It's this way: To keep all of the radiators hot, a small boiler will have to work to the limit, with a roaring fire and full draft on, while with a big boiler you'll get the same results with a fire that's not much more than smouldering. A big fire burning slowly takes less fuel and attention than a little fire that has to be pushed, so even though the larger size costs more, you'll be better off with it. Your house calls for 700 feet of radiation, and my recommendation would be a boiler giving 1,000."

"SOME friends of mine have their radiators in boxes," said Bob. "What kind are they?"

"Those are enclosures that you can put over any kind of radiator. That's the modern way of doing things. You can get them in any design to match your rooms. Or you can have copper or brass grilles built into the wall, so that all you see of them is a couple of grilles."

"I guess you'll get my order," said Bob. "I don't know enough to give it to you now, but I'll talk things over with my architect, and you'll hear from him."

THE Kersey's doctor limped in for dinner that evening and heard all about it. "Talking of heat," he said, "there's something I've noticed in my practice. There are two families around here that have the same number of children of about the same ages. One family calls me in every week or two to treat nose and throat troubles, while the other hasn't had a cold all winter. I've been trying to find what makes the difference, and I've come to the conclusion that it's in the heating of their houses. The family that has colds keeps the house at seventy degrees or more, and the air is so dry that it's like the Sahara. The other family has some way of moistening the air and I feel warmer and more comfortable there at sixty-five degrees than in the other house at seventy. In place of one of the radiators they have a machine that's connected to the boiler and water supply. In it is an electric fan that drives air over some heated parts and then over wet plates and sprays, and it comes out warm and moistened and spreads all over the house. I think that's a good plan, and I advise you to look into it."

Bob started on this new tack the next day and learned that health experts agreed with the doctor. Warm air needs moisture, he found, and if it cannot get that moisture anywhere else, will absorb it from human bodies. The unnatural drying of (Continued on page 158)

How to Choose a Heating Plant

(Continued from page 47)

skin and membranes gives germs a chance to attack, and diseases of the throat and nose are the result.

For healthful conditions the air must be humidified, and Bob was amazed to learn that, to be effective, this requires the evaporation of from three to six gallons of water a day for each room in the house. This not only will safeguard health but will preserve furniture and other woodwork and keep it from loosening and cracking. It is of little use to put a pan of water on a radiator, for there will be insufficient heat to evaporate the necessary volume. Such a plan is effective only with a special radiator tank that requires the rising warm air to pass through a coarse cloth that is kept moist.

MANY warm air heaters are fitted with tanks intended to moisten the air, but often these are so small as to be of little use. Some manufacturers now offer tanks that are connected to the water supply and kept filled by automatic valves. The most advanced apparatus is a warm air heating plant in which the air is kept in circulation by a fan. Entering the machine, it is filtered, warmed by passing through hot channels, and then humidified by sprays of water. It runs on gas, and temperature and humidity are under automatic control. The machine replaces a heater or a boiler, and because of its air passages to the different rooms, is best installed while the house is under construction.

Here was more food for thought, and after a long discussion with his architect, Bob decided to follow the advice of his friend, the salesman, and install humidifying radiators in the living room and the upstairs hall.

Next month—another entertaining article, in which the Kerseys tackle the problem of paint for their house.

Talking Robot Sells Flapjacks

(Continued from page 1)

the scales are put outside in the entrances. They work twenty-four hours every day.

Coin turnstiles are taking the job of ticket sellers in many firms, admitting passengers to subways, bus terminals, amusement parks, and the like. A small model has been worked out for street cars.

When the best known of the New York subway turnstiles were installed in 1918, each machine took the place of one man. When a nickel is dropped in the slot it makes an electrical contact which trips a dog and allows the arms of the stile to make a quarter turn. A ratchet allows the arms to be moved freely in the opposite direction. This prevents coming out use the same turnstile as those going in.

The new installation was faster and cheaper than the ticket choppers they displaced, but dishonest straphangers found that the machines would swallow slugs as readily as honest nickels. Soon an average of 3,000 slugs dropped daily into the coin receivers. Again the inventors got busy. The result was the bull's-eye. By this attachment the coin entered a lighted chamber and could be seen from the outside through a lens which magnified it to the size of a dollar. This lighted enlargement enabled the man in the near-by change booth or employee on the platform to see from a distance when a fraudulent disk was inserted. The bull's-eyes caused a drop of from 3,000 slugs to 600 slugs daily, a cash saving of $120.

Increased demand for automatic salesmen has brought 250 manufacturers into the market. They produce about 400 different machines.

(Continued on page 150)

Talking Robot Sells Flapjacks

(Continued from page 158)

Some of the stronger concerns have banded together in a $25,000,000 organization. They have been so active in the invasion of new territory and in working out new machines that organizations of clerks and salesmen have become genuinely alarmed for the future. The question whether the machines will throw human beings out of work is being agitated.

"It's the old story," says the president of one autovending concern. "Men are afraid of the machine invasion. We are sure this fear is groundless. Machines usually create more and better jobs. To cigar store salesmen, for example, the machines are aids, not competitors. A customer comes in for a pack of cigarettes. With the machine he can get what he requires in a few seconds. Without the machines he may have to wait ten minutes while the clerk talks to a 'shopper.' We figure that the machine should take care of the fifteen-cent sales and the clerk should devote himself to selling in larger amounts."

THE spread of the automatic vending idea is astonishing. Those in the business prophesy huge arcades where customers are waited on exclusively by vending and change-making automatons. Already there are stores of this sort. One at an amusement beach near New York sells fifty different commodities. Broadway has a "Solamat" in which eleven machines sell loganberry juice, root beer, orangeade, and the like.

One inventor has produced a machine that rivals the blond lady who stands in the restaurant window and deftly flips hot cakes. The automatic wheat cake vendor, electrically operated, has a magazine which will accept enough dough for a hundred servings. A quarter dropped into the slot entitles you to four wheat cakes and starts a fascinating series of operations. One by one the portions of batter drop on the hot plate. When one side is brown an automatic flipper turns the cake. The machine supplies syrup. Butter has to be served by hand.

Even gasoline now is sold by machine. The slot takes fifty cents. An adjustment allows the owner to set the amount according to the day's price.

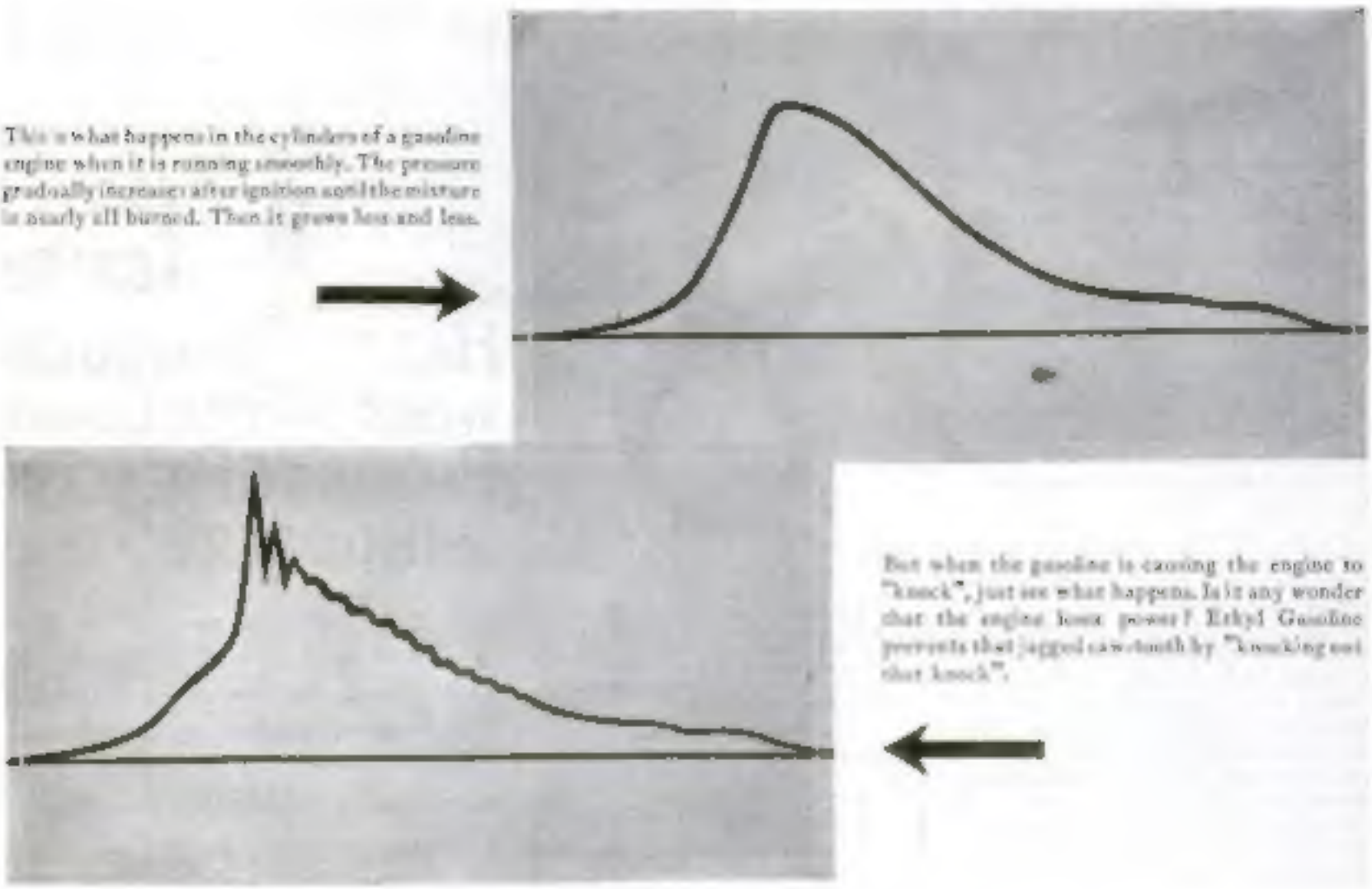
The owner of a washing machine business recently was stuck with a thousand old-fashioned units. Application of the coin-and-slot idea not only saved his financial hide, but is making his fortune. He put a time attachment on each machine and installed them in the basements of apartment houses. For twenty-five cents the housewife could use the washer for thirty-five minutes. The success of this venture was immediate and the business is being greatly expanded.

The sale of music and entertainment via the coin slot is as old as the penny arcade. From this humble beginning the automatic idea has spread into many and higher branches. There is a machine which plays twelve phonograph records for a nickel. Another gives you a selection from an automatic orchestra. Pianos with coin attachments have been greatly improved. The autoradio now is being installed in hotel rooms. A quarter buys fifteen minutes of radio programs—and static.

UNIVERSITIES and manufacturing plants are buying vending machines which sell candies and fruits. They save the time which a workman or student would waste going outside the building to hunt refreshment. Also they turn back a profit.

A fortune awaits the inventor who works out a successful machine for selling mixed drinks—ice cream sodas, for instance. The problems of refrigeration, of keeping the charged water and syrup, of mixing them properly, are a few which remain to be solved.

What is that "KNOCK"?



THE "knock" was a mystery in the automotive world until the scientists in General Motors Research Laboratories started on its trail. Before they finished they not only found out what that elusive "knock" was, but were actually able to take a picture of it!

This was made possible by the development of the Midgley Indicator, which records the pressure inside the cylinder of a gasoline engine. It was this ingenious device which first revealed the truth—that the "knock" was caused not by the engine, but by inherent faults in gasoline itself.

It showed that gasoline, when compressed beyond certain limits, explodes too fast—that is, "knocks" and loses power. Then the problem was to find something to mix with gasoline to control its combustion rate as compression was raised. After years of research it was found that Ethyl fluid, containing tetraethyl lead, was the solution.

Today leading oil companies mix Ethyl fluid with their gasoline to form Ethyl Gasoline. Ethyl made possible the engines of higher compression now on the market. By eliminating "knock" in engines of average compression it brings out additional power, gives them a new resiliency and nimbleness impossible to obtain with ordinary gasoline. Ride with Ethyl.

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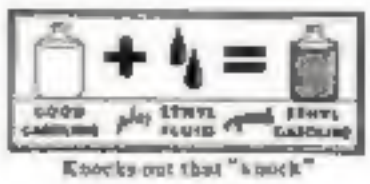

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